APPENDIX A

Zavoral Mine
Ecological Review of
Draft Environmental Impact Statement (DEIS)
SCANDIA, MINNESOTA

Submitted to:
Take Action – Conserve Our Scandia
Scandia, Minnesota

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INTRODUCTION

In December 2011, Applied Ecological Services, Inc. (AES) was retained by "Take Action – Conserve Our Scandia" to conduct a technical review of environmental review documents associated with the proposed Zavoral Mine, located near the St. Croix River in Scandia, Minnesota. The entire Zavoral Mine parcel (herein referred to as the "site") is 114 acres, with 64 acres proposed for mining. 55 acres of this was previously mined and 9 acres has never been mined or cultivated). AES's review focused on potential impacts to biological and other ecological resources at the site. AES did not review non- biological issues such as economics and traffic.

This report represents the products of AES's scope of work:

1. Summarize the project alternatives in the Draft Environmental Impact State (DEIS);
2. Assess the DEIS' adequacy in addressing issues identified in the Revised Scoping Decision Document (RSDD);
3. Identify ecological issues not addressed or inadequately addressed in the DEIS;
4. Assess the reclamation plan; and
5. Draw conclusions and key recommendations regarding the proposed mine.

PROJECT ALTERNATIVES

Alternative 1 – Preferred Alternative

In the applicant's preferred alternative, Alternative 1, Tiller Corporation proposes to mine and restore 64 acres of land, 56 acres of which was previously mined from the 1960s to the 1980s. The mine will remove sand and gravel to "an average depth of 15 feet, ranging from approximately 10 to 70 feet deep," followed by reclamation of the site. Approximately 4 acres of previously mined land in the St. Croix River District Zone and National Park Service scenic easement will not be mined but rather restored during the first five years of mining operations. Mining typically will occur from April through mid-November and will last up to 10 years. Reclamation of the site will be phased during each mining phase. Reclamation is proposed to consist of re-grading perimeter slopes, topsoil re-spread, vegetation establishment, monitoring and management.

Alternative 2 – No-Build Alternative

In Alternative 2 the property remains in its current condition with no mining or reclamation. The existing and allowed uses of the site include Agricultural and Rural Residential.

Alternative 3 – Reduced Timeframe

Alternative 3 is essentially the same as Alternative 1, except that the duration of mining would be up to 5 years.

Subalternative 3A – Reduced Timeframe (150-Working Day Operation)

Subalternative 3A is essentially the same as Alternative 1, except that the duration of mining would be approximately 1 year.

SUFFICIENCY OF DEIS

The Revised Scoping Decision Document (RSDD dated January 2010), identifies the alternatives and issues that are to be examined in depth in the EIS. It provides a tentative schedule of the environmental review process and discusses permit needs for the project. AES presents its review in the order of the RSDD format. AES includes other issues not addressed in the RSDD.

Alternatives Analysis

DEIS Review. Each of the RSDD-required Alternatives was addressed. Of these, Subalternative 3A is the most advantageous to natural resources.

The DEIS discusses the more intensive disturbance of Subalternative 3A:

- "Mining-related activity would be required more frequently or for longer durations, or a combination of both (pages ES-11, 4-7)";
- "…increasing the potential sources of erosion during operation (page ES-20)";
- "Noise levels are expected to be somewhat higher than Alternatives 1 & 3 due to the additional trucks on-site necessary to achieve the higher mining rate. Noise would occur for a longer period over the days worked at the Site and could be higher due to the higher tonnage required to be mined over the 150 working days. During hauling periods, noise levels along the haul route would be higher than for Alternatives 1 and 3; levels would be expected to be higher than those experienced during peak hauling in the past, but would occur over an estimated 1-year period (pages ES-33 and 4-99)";
- "As a result of the reduced timeframe, the daily traffic volumes and the hours of operation would increase in order to mine and transport the material from the Site (page 3-14)".

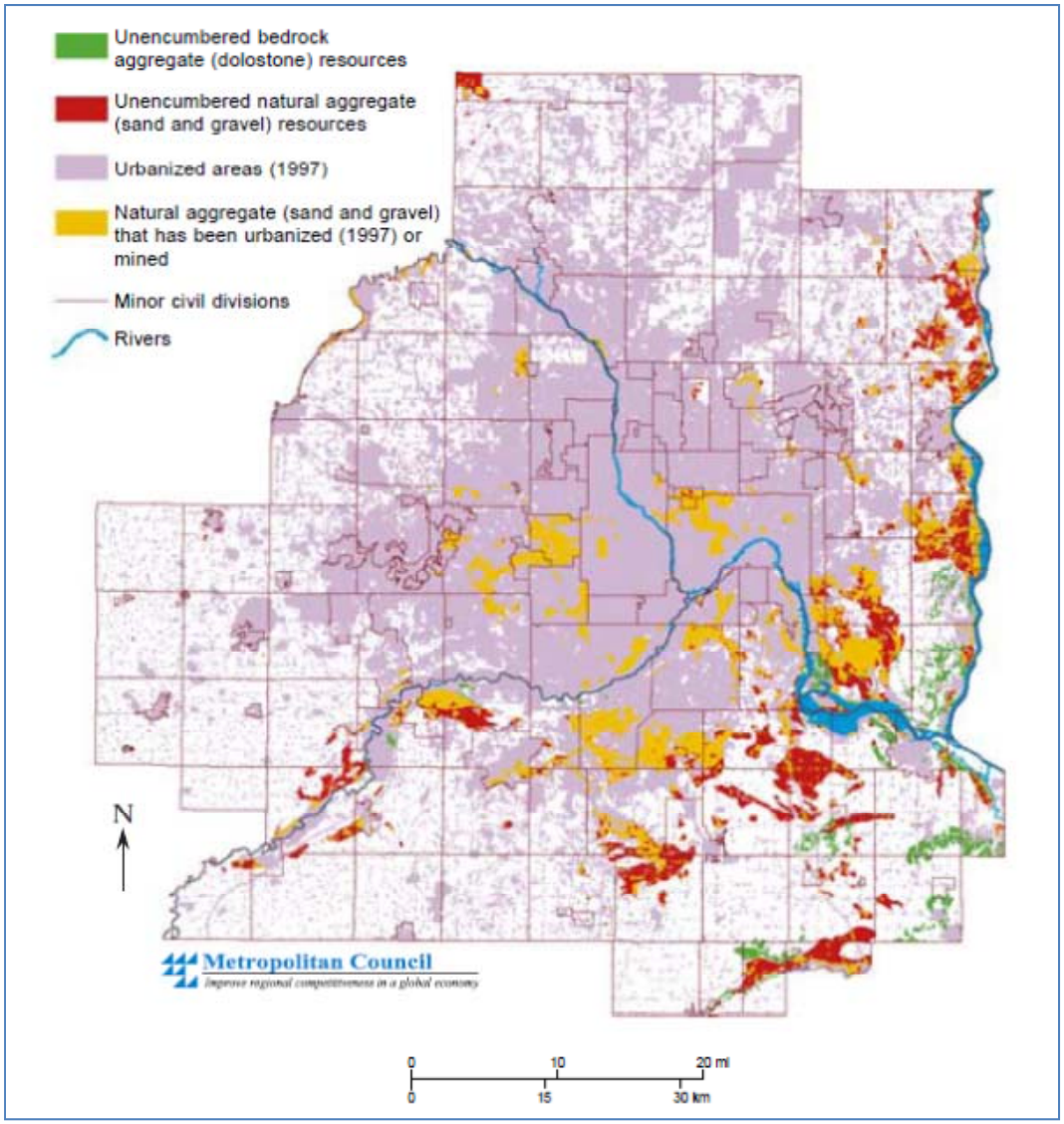
In contrast, the DEIS states that Subalternative 3A presents the lower probability of a major storm event during operation because of the reduced timeframe, and increased internal drainage and infiltration that would be established earlier than other alternatives.

AES views the addition of Subalternative 3A as welcome because any reduction in the duration of site disturbance and associated expediency in reclamation is generally advantageous from an ecological perspective. While disturbance may be more intensive during this compressed timeframe, the DEIS states that reclamation will be completed earlier and there will be a reduced period of wildlife displacement, which AES agrees with. However, the increased mining intensity and larger area of disturbed soil in a brief period during mining warrants increased site monitoring and inspections to ensure compliance and to safeguard against erosion and threshold exceedances, such as noise.

The DEIS also states that under Subalternative 3A the area would become available for post-mining use earlier. Given that the site's post-mining use is not known, it is not clear if this would have ecological advantages or disadvantages.

The Scoping Document did not require the assessment of alternative mining sites, but AES feels that alternative sites should be addressed given the ecological significance and sensitive of the site, discussed below. Alternative site consideration and analysis is a standard requirement in the Minnesota Environmental Quality Board's environmental review process, and the justification for not assessing alternative sites (RSDD, pg 8, "Alternative Sites") is inadequate.

Figure 1. Gravel resources of the Twin Cities region in 1997[1]



Numerous unencumbered deposits of sand and gravel are available to serve the metropolitan area (Figure 1). The Zavoral site is located within and adjacent to the St. Croix National Scenic Riverway, a unit of the National Park System, and within a MNDNR-identified Regionally Significant Ecological Area (RSEA). The public investment and highly valued natural resources here make this a significant environmental site. Other unencumbered sand and gravel resources exist nearby and do not impinge on significant natural resources or lands in which the public has made an investment. For this reason, these other gravel resources warrant consideration as alternatives to the Zavoral site.

[1] Southwick et al. 2000. Aggregate Resources of the Seven County Metropolitan Area, Minnesota. Minnesota Geological Survey Information Circular 46. Published in cooperation with the Metropolitan Council and University of Minnesota, St. Paul MN.

Reclamation Plan

The Reclamation Plan (DEIS Appendix A.2) provides a moderately detailed description of existing vegetation and soils, reclamation phasing, screening, and specific reclamation activities. These activities include site preparation, topsoil options, seeding, planting, erosion control, management, monitoring of performance standards, and potential mitigation measures. The reclamation plan calls for:

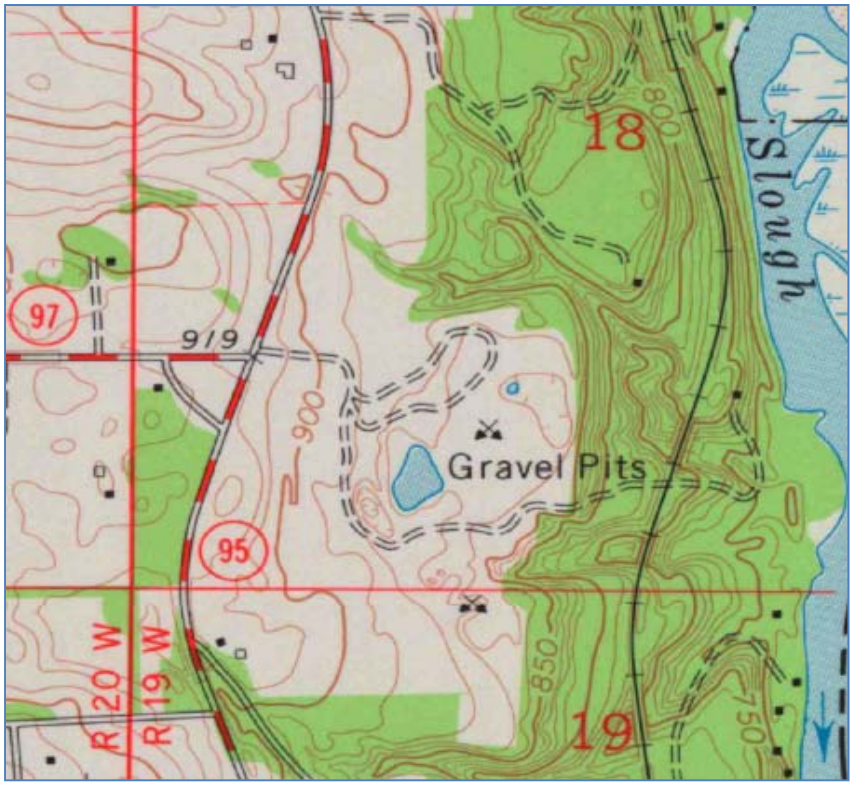
- Final slopes to be 4:1 (horizontal:vertical) or flatter;
- Mine floor will be graded to have 6 subtle depressions;
- Topsoil respread (DEIS proposes a minimum of 4 inches);
- Native seeding (dry and mesic prairie)
- Tree planting (transplanting white pine from the site);
- Maintenance (mowing, herbiciding, and prescribed burning); and
- Monitoring of performance standards.

AES supports most aspects of the reclamation design and agrees with these important elements. However, a few inadequacies were identified:

Mine Floor. The Reclamation Plan states, "There will be six (6) created depressions located throughout the proposed reclamation areas. These created depressions have a depth from 0.5 feet to 1.5 feet and range in size from approximately 20,000 sq.ft. to 75,000 sq.ft. These created depressions are not designed to allow stormwater to collect and stagnate or to convert to a wetland type environment…"

AES's review of historical topographic maps and aerial photographs indicate that past mining at the site resulted in open water ponds in excavated depressions (Figure 2). Past historical conditions suggest the possibility of similar conditions existing in the future. The DEIS should address the effect of ponded water on Crystal Spring, Zavoral Creek and spring-fed wetlands, such as the Black Ash Seepage Swamp, given the shorter subterranean flow path that will exist after mining than presently between the mine floor and these spring-associated resources.

Figure 2. Excerpt from USGS Topographic Map – Scandia, MN (1974)



Topsoil. AES agrees that engineered/manufactured topsoil, consisting of sandy materials on site, amended with weed-free organic material, is an acceptable method to provide the topsoil needed for reclamation. However, the Reclamation Plan states that "Topsoil to be placed within each reclamation area will be graded to a minimum of four inches in depth (page 13)." AES agrees with the City of Scandia in their recommendation that a minimum of 6 inches of topsoil be spread in all reclamation areas prior to native seeding.

Tree Planting. Tree planting is discussed but not clearly explained in the Reclamation Plan. Tree planting is apparently limited to transplanting white pines from on-site areas to existing forest edge areas and berms. The Reclamation Plan (page 26) states, "For reclamation areas that border the forested bluffs native coniferous trees will be planted to create a natural transition between the existing forested landscape and the newly planted reclamation areas. This transition area will be created along the north and eastern side of Reclamation Phases 1, 3 and 4 with the intent of establishing similar tree species that are found within the adjacent forest systems. This transition zone will allow existing tree species found along the forested bluffs to seed into the reclamation areas and contribute to the overall species composition over time." Figure 5 of the Reclamation Plan illustrates this intended "Coniferous Woodland" area.

AES agrees with using white pines as part of a forest edge restoration strategy. However, the single-species approach is not recommended and the extent of these plantings is insufficient to achieve the intended forest-to-prairie transition zone (see DEIS Appendix A.2, Figure 5). Transplanting only white pine will leave this Coniferous Woodland susceptible to disease due to the potential for white pine blister rust. Including other appropriate native trees (e.g., bur oak) and native shrubs would provide a more diverse, natural, and robust

edge to the forest. Coniferous Woodland should also be restored in a) Reclamation Phase 3 along the forested southern edge and along the forested portion of the western edge, and b) Reclamation Phase 2 along the forested portion of the northeastern edge.

The number of trees and their spacing are not specified. An adequate density of trees is necessary to providing meaningful benefits in the zone between remaining forest and the open areas of the mine. The City of Scandia should require that the mine reclamation plan specify a tree planting plan that restores Coniferous Woodland along all remaining forest edges at an adequate density to establish tree canopy closure within 5 years.

Maintenance. The Reclamation Plan's maintenance tasks and schedule are generally adequate with two exceptions. The Reclamation Plan calls for a 3-year maintenance period, which is inadequate for a restoration of this nature, especially due to dry and sandy soils. The significant ecological values of the location also require a longer period of monitoring. AES recommends a minimum of 5 years of maintenance and monitoring after mining is completed, as discussed below.

Year 3 maintenance recommends a prescribed burn. While AES agrees that prescribed burning is an appropriate maintenance technique for the prairie portions of the site, Year 3 may be premature for a burn due to low fuel accumulation due to the site's dry and sandy soils. The plan should provide flexibility to wait until Year 4 or 5 to burn, based on the site's response to restoration and maintenance activities.

Monitoring and Performance Standards. Performance standards were neither rigorous nor prescriptive, especially for Years 2 and 3. In particular, acceptable areal cover by seeded native species is not specified nor is the permissible areal cover of non-native and invasive plants.

For year 1 monitoring (page 22) the Reclamation Plan states that, "Seedlings of at least 3 native grasses and 3 native forbs should be widely dispersed through the seeded area." The term "widely dispersed" must be defined and agreed to by the City. There is also no mention of an acceptable area of bare ground during Year 1. The standard metric for assessing disturbed sites to ensure adequate soil stabilization is that no areas of bare soil larger than 3x3 feet shall exist within the restoration area.
For year 2 monitoring (page 23) the Reclamation Plan states, "Prairie sites will generally be dominated by cool season native grasses…" The term "dominated" needs to be defined and agreed to by the City. There is also no mention of an acceptable area of bare ground during Year 2.

Year 3 Monitoring (page 23) is unclear regarding the performance standards to be achieved. These require defining and approval by the City.

No monitoring is proposed beyond Year 3. Given the presence of invasive plants already on and adjacent to the site, it is likely that future invasions by non-native plants and noxious weeds will occur beyond Year 3. Likewise, erosion may occur on the site over time, requiring stabilization. Not addressing erosion could result in slope failure and degradation of downslope/downstream water quality and habitat.

More specific and rigorous performance standards are necessary to ensure the success of the reclamation, and consequences for not meeting performance standards should be specified (e.g., City should require remedial action followed by City review and approval prior to release of performance bond).

Other Issues Addressed by the DEIS

According to the RSDD, several items were screened and removed from further review. Most of the issues identified in the RSDD were addressed in the DEIS. However, several issues were not addressed, and many additional issues were not addressed adequately. RSDD-identified topics to be included in the EIS are listed below, followed by AES' sufficiency review of each topic. We did not address issues that are not explicitly listed below.

Item 9 – Land Use/Potential Environmental Hazards/Reclamation Plan. The RSDD states that the DEIS is to provide a detailed description of the reclamation plan for the site. The Reclamation Plan provided in the DEIS (Appendix A.2) addressed many issues regarding gravel mine reclamation; however, several issues were not addressed adequately. The Reclamation Plan was discussed above.

Item 10 – Cover Types. The site is located in a region containing many high-quality native plant communities. Significant land cover types in the proposed mining area consist of two plant communities:

- White Pine-Hardwood Forest, BC Rank (good quality)
- Maple-Basswood Forest, BC Rank (good quality)

Adjacent to proposed mining area are additional native plant communities, including:

- White Pine-Hardwood Forest, BC Rank (good quality)
- Maple-Basswood Forest, BC Rank (good quality)
- Black Ash swamp Seepage Subtype, No Rank
- Mesic Southern Cliff (Maderite Cliff), No Rank

It is unclear in the DEIS whether construction of the proposed earthen berms on the west and south edges of the mine would extend beyond the proposed mining and reclamation boundary, and in particular, it is unclear if construction, maintenance, and/or removal of the berms will impact any previously unmined forest areas. If berm activities will impact previously unmined forest, this would represent additional loss of native White pine-hardwood forest and Maple-basswood forest. Also, if the berms are to be removed post-mining, this will again disturb and open up the adjacent forest to edge effects.

Item 11—including 11a—Fish, Wildlife, and Ecologically-Sensitive Resources, and Item 11b—Threatened and Endangered Species. The MNDNR Natural Heritage Information System (NHIS) identified 70 records of rare plants, animals, fishes, reptiles, mussels, and native plant community occurrences within a 1-mile radius of the Site. This high density of rare natural features underscores the ecological significance of the site and its vicinity. Of the 70 records, the MNDNR Natural Heritage Program staff determined that the following state-listed species would have the potential to occur on the Site and, if present, would have the potential to be affected by project activities:

- Kitten-tails (*Besseya bullii*; Minnesota Threatened)
- Bog blue grass (*Poa paludigena*; Minnesota Threatened)
- American ginseng (*Panax quinquifolius*; Minnesota Special Concern)
- Red-shouldered hawk (*Buteo lineatus*; Minnesota Special Concern)
- Blanding's turtle (*Emydoidea blandingii*; Minnesota Threatened)
- Several threatened and endangered species of mussels occurring within the St. Croix River

Surveys conducted for Blanding's Turtle, Red-shouldered Hawk, and rare plants did not identify these species on the Zavoral site. However, three raptors were observed and recorded during the call-response surveys for Red-shouldered hawks within the Site during the May 2010 surveys**,** including two Red-tailed hawks (*Buteo jamaicensis*) and one Bald eagle (*Haliaeetus leucocephalus*, Minnesota Special Concern).

A population of 33 Butternut (*Juglans cinerea*) trees, a Minnesota Special Concern tree species, was identified on the property. Of these 33 trees, only one healthy specimen found on the site; the rest of the Butternut trees showed signs of infection by Butternut Canker (*Sirococcus clavigignenti-juglandacearum*). Based on DEIS Figure 24, approximately 13 of these Special Concern trees (all located in the southern portion of the proposed mining area) will be destroyed during mining activities. According to the MNDNR, "A species is considered a species of special concern if, although the species is not endangered or threatened, it is extremely uncommon in Minnesota, or has unique or highly specific habitat requirements and deserves careful monitoring of its status (MNDNR, 2007)."

The DEIS addresses several issues regarding fauna, flora, and their associated habitats; however, mining immediately adjacent to a National Park easement (providing no buffer) and the removal of part of a Minnesota Department of Natural Resources (MNDNR)-identified Regionally Significant Ecological Area (RSEA) are not addressed.

The St. Croix National Scenic Riverway and associated National Park and easements will be adversely affected by the proposed mine because no buffer is provided between the active mine and the edge of the easement, which is part of a MNDNR-defined Regionally Significant Ecological Area and part of a larger block of habitat that contains many wildlife species, including rare plants and animals (see Appendix A).

The DEIS focuses only on the site and direct impacts from changes in land cover and habitat conversion. Discussion is lacking regarding the site's larger ecological context, rare species located near and adjacent to the site, and impacts likely to result from habitat fragmentation and edge effects, including noise impacts to wildlife (see Item 24 below).

Despite the regional significance of the location, coordination between the client and the NPS, MNDNR, and USFWS was not apparent beyond the 2008 and the 2011 Natural Heritage Database request letters to the MNDNR. AECOM has not yet received a response from their 2011 request letter; therefore, current MNDNR rare natural feature records associated with the site have not been considered in the DEIS.

The MNDNR has requested that Blanding's Turtle mitigation measures be applied to the project. However, it is unclear whether Tiller plans to implement any of these measures or if they will be required by the City to comply with this MNDNR request.

Item 12 – Physical Impacts on Water Resources. The DEIS does not address the RSDD-specified issue of the reversibility of potential impacts. If impacts to surface waters occur, repair and restoration techniques should be specified as well as the anticipated degree and timeframe for ecosystem recovery.

Item 13 – Water Use. AES did not assess this issue, but note that on page ES-6 there is an omission under Subalternative 3A where no gpd is listed in the last line.

Item 16 – Erosion and Sedimentation. The DEIS does not address the RSDD-specified issue of specific measures (e.g., BMPs) that will be implemented to avoid, minimize or mitigate identified impacts. Many techniques commonly referred to as BMPs have limited value in controlling erosion and sedimentation; therefore, the specific measures proposed should be listed and described, as required by the RSDD.

Zavoral Creek is a significant resource, supporting 400+ Brook Trout per mile of stream, based on MNDNR survey data. Water quality is excellent and water temperatures are fairly stable at around 10.5 C on average. The stream, however, is relatively small, with average flows of 3-4 cfs and a mean depth of 1-2 inches. Given its small water volume, the stream has little capacity to absorb pollution, and the Brook Trout are highly sensitive to pollution, such as sediment. Sediment pollution to Zavoral Creek is a possibility given that a portion of the proposed mined area will drain directly to the creek. There is one mention in the DEIS that two silt fences will be erected, possibly with vegetation filter strip, but without a specific location. Elsewhere the DEIS states that a single silt fence will be erected. Given the highly sensitive nature of Zavoral Creek, the City should require that erosion control include a detailed plan to construct and monitor erosion control BMPs in order to prevent discharge of pollution to Zavoral Creek during active mining.

Item 17—Surface Water Quality and Quantity. The DEIS does not address the RSDD-specified issues of:

a) identifying and mapping the location of springs in the project area and areas of potential impact;
b) providing water quality data for Middle Creek and South Creek; and
c) quantifying impacts of specific pollutants (e.g., phosphorus, TSS, heavy metals, PAHs, VOCs, temperature) on receiving waters.

The DEIS should describe how sediment and other pollution from inadequately management mine runoff may affect Brook Trout and aquatic macroinvertebrates in Zavoral Creek. It should also discuss how the vegetation at spring discharge points, such as the Black Ash Seepage Swamp, could be affected by changed in groundwater discharge.

Page ES-18 of the DEIS states, "The reduction of surface water flow and increase in infiltration would benefit cold water species in Zavoral Creek, such as trout," and page ES-19 states, "The Project would improve infiltration, resulting in slightly improved base flow conditions for the seeps, springs, and creeks, enhancing the ability of area creeks to support aquatic life, including cold water species such as trout." These environmental changes are not clearly beneficial to the springs and trout. The site currently experiences little surface runoff, and increased internal drainage within the mine pit may lead to ponding and subsequent warming of spring recharge waters (based on historical mine conditions illustrated in Figure 2). This could raise the temperature of nearby springs and creeks (including Zavoral Creek), adversely affecting trout and other cold-water species. The DEIS should estimate the potential for warm ponded water in the mine to warm the streams and springs that receive groundwater discharge from the mine site.

Item 24 – Odors, Noise and Dust. The DEIS does not address in detail the RSDD-specified issue of describing noise sensitive areas and habitats. Addressing noise sensitive areas and habitats requires the identification and discussion of sensitive wildlife species in the area, which are not limited to the DEIS-discussed state-listed species would have the potential to occur on the Site and, if present, would have the potential to be affected by Project activities. For example, many territorial species of songbirds have been shown to be very sensitive to even low levels of noise and several are documented to nest on the nearby Falls Creek Scientific and Natural Area and should be expected in the National Park Service easement adjacent to the mine site[2]. Neither this issue nor the effect on these species is addressed in the DEIS. Noise, which is a type of edge effect (see below) can result in extensive indirect impacts to certain species.

[2] Forman, R.T.T. et al. 2003. Road ecology: Science and solutions. Island Press, Washington D.C.

Item 26 – Visual Impacts. Visual impacts should address not only human receptors, but also sensitive wildlife species. Visual impacts of clearing vegetation and active mining should be discussed and assessed in relation to wildlife impacts.

Potential Mitigation Measures in the DEIS

The DEIS presents numerous "potential" mitigation measures, summarized on page ES-35 and 5-1. AES believes that many if not all should be required by the City of Scandia prior to approving mining at the site. The DEIS also contains many recommendations that it states "should" be implemented or are "recommended." This provides little clarity and no assurance that these mitigation measures will indeed be implemented and enforced. A list of mitigation measures agreed to by the mine operator and City should be provided with the Final DEIS.

Below are the DEIS's potential mitigation measures related to AES's ecological review. For each one, AES provides comments.

1. Require Tiller to provide a funding mechanism to conduct any and all required monitoring at the Site.
    - AES agrees that secure funding is necessary to ensure the approved monitoring is conducted. This should be in the form of a performance bond or similar mechanism. This monitoring should be conducted by a qualified restoration ecologist operating independently of Tiller in order to ensure objectivity.
2. Require a vegetation establishment and monitoring period of at least 5 years after completion of the Project.
    - The Reclamation Plan calls for a 3-year monitoring period, which is inadequate for a restoration of this nature, especially due to dry and sandy soils. AES agrees a minimum of 5 years of monitoring and maintenance, as discussed above) should be required in all reclamation areas.
3. Develop an adaptive management plan to address long-term management issues.
    - AES agrees a site-specific adaptive management plan is important to the long-term success of the reclamation.
4. Identify the responsible party and funding source for active long-term stewardship of the Site.
    - AES agrees this long-term stewardship funding is critical to the long-term success of the reclamation.
5. Monitor the proposed transplanting of native White pine trees to verify maintenance and watering and to assess survival rates. If survival rates do not fall within a predetermined range established by the City, replacement trees should be provided by Tiller.
    - AES agrees monitoring, survivorship requirements, and replacement requirements are important. However, tree planting zones and densities need to be defined and established in the field in order to determine an appropriate survivorship rate.
6. Establish specific criteria for measuring and defining reclamation success that are acceptable to the City (i.e., percent cover requirements for seeded native species; limits on aggressive native species, invasive and exotic species, and so on). The diversity of the proposed reclamation must be met in order for the cover type and wildlife habitat evaluations in this EIS to be acceptable.
    - As discussed above, AES agrees that performance standards require greater rigor and clarity to result in successful reclamation.

7. Specify actions that would be taken by Tiller if reclamation were determined not to be successful and conditions under which reseeding, overseeding, and/or spot seeding or other management methods would be required.
    - As discussed above, AES agrees that performance standards require greater rigor and clarity to result in successful reclamation.
8. Construct the berm on the south end of the Site as close to the mining and reclamation limits as possible. This would result in lower off-site peak flow rates and increased on-site infiltration.
    - As discussed above, it is unclear whether additional forest impacts will result due to the construction, planting, and potential removal of screening berms.
9. Require that the WCD monitoring point installed for the pump test and collection of baseline data in Zavoral Creek be monitored during the lifetime of the Project. This monitoring should be funded by Tiller.
    - AES agrees that this monitoring should be conducted, as should monitoring of Middle and South Creeks.
10. Monitor the Black ash swamp seepage subtype wetland boundary mapped by CCES (CCES January 2010) that established the baseline boundary of the seep along Zavoral ravine. This monitoring should be funded by Tiller.
    - AES agrees the wetland boundary should be monitored; however, quantitative vegetation data should also be collected from this sensitive native plant community since changes in water temperature and quality, if they occur, would affect the vegetation composition of the wetland more than the wetland's boundary.
11. Monitor the mitigation methods used at the Site to reduce emissions of fugitive dust for the life of the Project. Records of the sweeping and water application would be maintained to document the fugitive dust control measures. The City should require Tiller to provide a funding mechanism to conduct any and all City-required monitoring at the Site to confirm that sufficient dust control measures are being implemented.
    - AES agrees that such monitoring is warranted, especially with the proximity of sensitive rare wildlife species such as trout and mussels.
12. Require noise mitigation techniques, such as developing berms and screens for the Zavoral Site, are implemented. Tiller should provide a funding mechanism for monitoring.
    - AES agrees noise monitoring is important, as adverse effects on native songbirds and potentially other species are expected during the operation of the mine.
13. Monitor to ensure that the proposed screening and reclamation strategies are successfully implemented.
    - AES agrees monitoring is important to control visual impacts (to wildlife as well as humans), and monitoring to ensure proper implementation of the Reclamation Plan and maintenance regime is critical to the project's success and compliance with the DEIS.
14. Establish Minimum Topsoil/Manufactured Topsoil Thickness: Proposed topsoil thickness must be reviewed and approved by the City. Tiller proposes 4 inches, which is the minimum allowed by the City ordinance; a common industry standard is 6 inches. Six inches of topsoil/manufactured topsoil is preferred and it should not be tilled, to reduce the potential for compaction.
    - AES agrees 6 inches of topsoil is more appropriate for the site.
15. Test Site Soils: Once soils are tested, recommendations can then be made as to whether on-site soils could be modified to provide an acceptable topsoil. A qualified agronomist should evaluate

sand/silt/clay structure, fertility, and pH of on-site soils and make recommendations regarding its use as topsoil.

- AES agrees such testing is prudent, especially given the dry and sandy soils that will remain post-mining and the paucity of on-site topsoil.

16. There is limited topsoil available on the Zavoral Site due to past mining activities. As a result, the material at the Site would need to be modified to produce an engineered or manufactured topsoil as described in Tillers reclamation plan, or topsoil would need to be brought to the Site from other locations.
    - AES agrees that engineered topsoil is acceptable if it meets the specifications, and off-site topsoil would require assurances that is contains no weed seed.
17. To provide a suitable planting medium for the establishment of vegetation at the Site, the City would need to develop a topsoil and/or manufactured topsoil specification that meets the needs for this and other mining proposals. Criteria need to be established for what materials are suitable and the City needs to have approval authority. A single source supplier of organic material (e.g., municipal leaf compost, yard waste recycling company) should be used to maintain consistency of imported material and to ensure uniformity in resulting manufactured soil. Standards also need to be established for the use of on-site or other topsoil to avoid the use of topsoil containing invasive or weed species.
    - AES agrees the topsoil specification is important to reclamation success, and assurances regarding absence of invasive weed seed should be required by the City.
18. Describe Subgrade Preparation: The subgrade should be disked and amended with compost or other amendments as necessary. Placed topsoil/manufactured topsoil should not be disked. It would be preferable to disk the subgrade soils to eliminate a barrier/impedance between soil layers/horizons (i.e., create positive drainage and ensure groundwater recharge).
    - AES does not understand the rationale behind prohibiting topsoil disking. However, the approach recommended above is acceptable.
19. Modify Seed Mix and Methods: The proposed seed mixes should require 100+ seeds per square foot of permanent native seed for successful establishment of natural areas. An inoculant should be used during seeding to improve growth. Native seed mixes should be installed using broadcast sowing on the soil surface given loamy-sandy soil types, followed by the installation of straw erosion control blanket (straw blanket North American Green [NAG S-75 type) rather than straw crimping.
    - AES agrees that the above requirements will contribute to successful native seeding.
20. Modify Cover Crop Specification: The temporary cover crop and how the Site would be prepared for permanent seeding after the cover crop is established should be clearly specified. The steps that would be taken for the temporary to permanent seeding process if optimal timing is not achieved should be described. A higher frequency of mowing and herbicide treatment during the establishment period should be considered, three times during the growing season is recommended. Tiller's reclamation plan should include a list of acceptable herbicides. An adaptive management plan should be developed.
    - AES agrees that greater detail should be provided in the Reclamation Plan, as well as development of an adaptive management plan.
21. Describe Tree Transplanting: Describe how many trees, their size, transplanting method, and the location, and arrangement of plantings. Consider savannah habitat as transition from native grassland to forest.

- As discussed previously in this report, tree planting details are lacking in the Reclamation Plan. In addition, a larger area of plantings is required due to the adjacent high-quality native forests located on the National Park Service easement and other locations at the proposed mine site.

22. Refine Invasive and Aggressive Native Species Control: Weedy species should be better defined (a list of such species has since been provided by the WCD through the PAC. In addition:
    a. Add spotted knapweed (extremely invasive) control.
    b. Add management methods for common buckthorn control, which is one of the most critical tasks in forest management.
    c. Add reed canary-grass control methods.
    d. Identify methods to keep boxelder, quaking aspen, and eastern red cedar that are prone to being weedy in check.
    e. Remove non-native honeysuckle species from the Site.
    f. Add to overall forest management including the use of a rotational burn, with follow-up reed canary-grass management, to suppress the growth of nonnative woody species and encourage species diversity.
    g. AES agrees that target invasive and non-native plants should be specified. Rotational burning can be an effective management tool when used properly, and is appropriate in portions of the site.
23. Establish Funding Mechanism: Tiller should provide a funding mechanism for the City to conduct any and all required monitoring at the Site to assess the success of proposed reclamation.
    - AES agrees that Tiller-funded monitoring conducted by the City or another independent entity is prudent to ensure objective monitoring and reporting.
24. Specific criteria for measuring and defining success acceptable to the City need to be established (percent cover requirements for seeded native species, limits on aggressive native species, invasive and exotic species, and so on). Actions that would be taken by Tiller if reclamation were determined not to be successful need to be specified. Conditions under which reseeding, overseeding, and/or spot seeding are required should be identified.
    - AES agrees that greater specificity regarding performance standards is required, as well as a discussion of remedial actions that will be taken if performance standards are not met.
25. Extend Monitoring Period: The City should consider extending the establishment and monitoring period to 5 years from 3 years as proposed by Tiller. An adaptive management plan should be developed.
    - AES agrees that maintenance and monitoring should be conducted for at least 5 years due to the sites dry and sandy soils and the sensitivity of adjacent high-quality native habitats.
26. Address Long-Term Management: The City should address long-term management and identify related responsible party and funding source for active long-term stewardship of the Site.
    - AES agrees that the site's adjacency to high-quality native habitats and a National Park Service easement warrants careful consideration regarding long-term stewardship. An appropriate, site-specific, long-term stewardship plan should be developed and funding secured to ensure its continuation.

ISSUES NOT ADDRESSED BY RSDD AND DEIS

Regional Ecological Context

The proposed mine is located adjacent to the St. Croix National Scenic Riverway and associated National Park easement (Map Exhibit 2). The nearby St. Croix River is classified as a National Wild and Scenic River. The proposed mining area extends to the St. Croix River District boundary, as well as to the edge of the St. Croix River bluff and three ravines leading down to the river. No buffer is proposed between the proposed mine and the easement.

The St. Croix River corridor is recognized as a major recreation area, as well as a regional flyway for migrating songbirds. The corridor provides habitat (including large, contiguous forest and other natural lands) that is important for interior forest birds, numerous raptor species, other area-sensitive wildlife, and many rare plants and animals.

A portion of the site is located within a high-quality Regionally Significant Ecological Area (RSEA) extending along the St. Croix National Scenic Riverway (Map Exhibit 1). RSEAs represent large natural and semi-natural habitats that have the potential to, and often do, provide critical habitat for many native species, including rare plants and animals. The RSEA also is in a Conservation Corridor defined by the MNDNR. The proposed mine would encroach upon this RSEA and the greater wildlife corridor extending up and down the St. Croix River Valley.

While some of these individual natural features and conservation lands are mentioned in the DEIS (page ES-15 and Figure 3), the regional ecological significance of the project area is not discussed. The site's regional ecological context includes high quality forests, the RSEAs, and the St. Croix River Valley's large habitat blocks and regionally-significant wildlife corridor (Map Exhibit 1).

Several significant public investments have been made for conservation in the vicinity of the proposed mine site (Map Exhibit 2). These public investments include William O'Brien State Park, Rutstrom State Wildlife Area, Falls Creek Scientific and Natural Area, Farmington Bottoms, and Wind in the Pines Park. The National Park Service easement that is adjacent to the mine also represents a public investment in conservation. The proposed project provides no buffer between the mine and the NPS easement associated with the adjacent National Park.

The site's location next to a National Park, within an RSEA and a DNR-defined conservation corridor, and among large and important public conservation areas underscores the environmental significance of the mine's location and vicinity and the sensitivity of the natural resources in the vicinity to adverse effects of development activities, including mining.

Historical Data Review

In order to better understand the site's ecological setting and historical context, AES reviewed historical vegetation maps, historical aerial photographs, and historical topographic maps.

Pre-European Vegetation Mapping. Prior to European settlement of the region (early-mid 1800s), the site was in a transition between aspen-oak land (on the very western edge of the site and extending to the west) and oak openings and barrens (the majority of the site and extending to the east) (Marschner, 1974). These plant communities contained vegetation associated with prairies and typically experienced regular fires (likely ignited by Native Americans). The canopy would not have been fully closed to acquire a description of

openings and barrens, which signifies canopy cover less than in a forest. Since European settlement, fire suppression has likely contributed to the more closed, mesic forest systems seen along the St. Croix River Valley today.

Historical Aerial Photos. Historical aerial photographs of the site were obtained from Historical Information Gatherers (HIG) in order to assess site conditions over time, particularly site conditions prior to past mining of the site. Photos were obtained from the following years: 1938, 1953, 1957, 1964, 1970, 1980, 1986, 1991, 1997, 2003, 2010 (Appendix B of this report). A discussion of each photo follows.

1938 – This photo indicates the majority of the proposed mining area had already been cleared for agricultural production as of the late 1930s. What the DEIS refers to as "Middle Creek" was more intact in 1938, with banks/slopes consisting of savanna and extending across the center of the proposed mining area to the east. The savanna area was likely grazed by livestock. What appeared to be a meandering ditch traversed the northwest portion of the proposed mining area, eventually discharging into Zavoral Creek. The ravines and bluffs located east of the proposed mining area appeared to consist of forest and moderately-dense savanna. What appears to be a small sand/gravel pit is evident in the southwest corner of the site (outside of the proposed mining area). Transportation infrastructure was already present around the site in 1938, including St. Croix Trail North (State Trunk Highway 95 [TH95]) and TH 97 to the west, Quinnel Avenue North to the south, and the Soo Line Railroad to the east.

1953 – This photo is similar to the 1938 photo with the notable exception that what appears to be a small sand/gravel pit is evident in the east-central portion of the proposed mining area. The previously evident sand/gravel pit in the southwest corner of the site appears to have been enlarged slightly since the 1938 photo.

1957 – This photo was similar to the 1953 photo with the notable exception that the sand/gravel pit in the east-central portion of the proposed mining area had been expanded to the north.

1964 - This photo was similar to the 1957 photo with no notable exceptions. The areas previously appearing as moderately-dense savanna (along Middle Creek and east of the proposed mining area) appear to have filled in, consisting of more closed canopy forest. This would have resulted if livestock grazing were stopped. It appears that some trees east of the southeast corner of the proposed mining area died or were removed since the 1957 photo.

1970 – Sand/gravel mining had expanded substantially since 1964, with the 1970 photo showing mining occupying the entire northeastern portion of the proposed mining. The ravine associated with Middle Creek had been encroached upon from mining expansion on the north, and what appeared to be a small test pit had been dug south of the Middle Creek ravine. The previously meandering ditch located in the northwest portion of the proposed mining area had been realigned as a straight ditch located along the northwest edge of the proposed mining area.

1980 - Sand/gravel mining had expanded further south and northwest since 1970. The upper reaches of Middle Creek had been cleared and traversed with unpaved roads. Trees and/or shrubs had grown up along the northwest ditch.

1986 – This color infrared aerial photo showed that mining had not expanded significantly since 1980. The main pit (in the northern portion of the proposed mining area) appeared deeper, but revegetation of some previously bare areas appeared to have occurred over the preceding six years.

1991 – Significant changes on the site were not conspicuous from the period 1986 to 1991.

1997 – Again, significant changes were not conspicuous since 1986. Several stockpiles located in the east-central portion of the proposed mining area appeared to have been partially excavated since 1991. Some of the mined areas appeared to be revegetating

2003 - Significant changes were not conspicuous since the 1997 photo. The mined areas continued to revegetate.

2010 – This last aerial photo in the sequence appeared very similar to the 2003 photo. Mined areas continued to revegetate. Figure 17 (Existing Land Cover Map) in the DEIS illustrates the extent of this revegetation

.

Historical Topographic Maps. Historical U.S. Geological Survey (USGS) topographic maps were reviewed, including the 1974 Scandia 7.5-minute map, the 1993 revised version of the same map, and the 2010 updated map (Appendix C of this report). The 1974 map illustrated the majority of the proposed mining area to consist of open (non-forested) land. "Gravel Pits" were identified in the northeast, east-central, and southeast portions of the proposed mining area, and unpaved roads were shown traversing the northeast and central portions of the proposed mining area connecting TH95 on the west to a small structure (likely a house) located on the bluffs east of the proposed mining area. A moderate-sized body of open water was shown near the center of the site, a smaller open water area was shown in the northeast portion of the proposed mining area, and a deep depression was shown just southwest of the larger open water area. Forest/woodland was shown east, north, and south of the proposed mining area, as well as in the formerly unmined area proposed to be mined by Zavoral.

The 1993 revised topographic map was very similar to the 1974 map in the site area, with two conspicuous exceptions. First, the larger body of open water in the proposed mining area was no longer shown. Second, the alignment of the site's unpaved road had been changed through the proposed mining area; however, the road still connected TH95 to the small structure on the bluff.

The 2010 map (created using 2009 aerial photography, 2009 hydrography, and 2002 contour data) illustrated conditions similar to current site conditions; however, the road passing through the site ended in the southeast portion of the proposed mining area, near a small body of open water.

Summary of Historical Data Assessment. Based on our review of pre-European settlement vegetation (representative of the mid-1800s), historical aerial photos (1938-2010), and historical topographic maps (1974, 1993, and 2010), the site's original vegetation was likely dominated by oak savanna. By 1938 and through 1964, the majority of the proposed mining area had already been converted to agricultural fields. Sand/gravel mining appears to have been at least intermittently active on the site by 1938 (when a small area in the southwest portion of the site appeared to have been mined). Mining was observed in the proposed mining area in the 1953 photo. Between 1964 and 1970 the sand and gravel operation expanded significantly. By 1980 there was an additional expansion of sand and gravel operations. From 1980-2010 little alteration of the site occurred, and natural revegetation progressed significantly on the mined areas.

Habitat Fragmentation

The Zavoral Mine site has naturally been recovering from previous mining activities for over 30 years. While the landscape of the mined portion of the site has obviously been altered, natural and semi-natural vegetation has colonized and developed, creating a diversity of habitats, including forests, woodlands, and grasslands with scattered trees. This process of revegetation has started to "fill in" the proposed mining area and

provide greater forest/woodland connectivity in the regional habitat corridor (Map Exhibit 1) and greater ecological buffering of adjacent high-quality native forest (Map Exhibit 3). The existing habitats within the proposed mining area, coupled with the adjacent, high quality native forests, currently provide nesting, foraging, and breeding habitat for native wildlife species, including small mammals, birds and insects. This process of passive revegetation has begun to mitigate some of the previous mine's direct impacts as well as its indirect impacts on the greater landscape. Left alone, these habitats would continue to evolve such that the entire proposed mining site would become a forest, expanding the contiguous forest habitat and widening the regional wildlife corridor.

The proposed mine would fragment local habitat as well as the regional wildlife corridor. Map Exhibit 3 illustrates the loss of forest and woodland that would result from the proposed mine, including 5.4 acres of native forest that was not cleared during previous mining activity, and 18.2 acres of woodland buffer that has passively revegetated on the site since mining ceased. Additionally 33.6 acres of other semi-natural habitat would be cleared and lost as a result of the mine. These habitat losses would reset the recovery of the site, which has been progressing for 30 years, and open up the adjacent high-quality native forests to indirect impacts, including a variety of edge effects, discussed below.

Edge Effects

While the DEIS addresses many direct ecological impacts that would be associated with the proposed mine, indirect impacts on ecological resources are not addressed adequately. Edge effects represent a suite of indirect impacts that occur adjacent to land use changes[3]. Edge effects that would be expected to occur as a result of the proposed mine include:

Noise Impacts. While described in the context of human receptors, the DEIS does not address noise impacts on wildlife. Research has shown that wildlife species such as some forest passerine birds (e.g., Wood Thrush, Ovenbird, Least Flycatcher, Yellow-throated Vireo, and Cerulean Warbler) are adversely affected by the increased noise levels that are predicted to occur as a result of the Zavoral Mine, as far as ¼- mile from the mine[4]. Forest breeding bird habitat of approximately 172 acres is expected to be affected by noise from the mine (Map Exhibit 4), based on noise modeling presented in the DEIS.

Visual Impacts. Mining equipment, hauling trucks, and decreased screening and buffering will disturb wildlife far beyond the edge of the mine pit.

Invasive Plant and Predator Impacts. Re-opening the forest edge to disturbance provides an opportunity to introduce many invasive plant species. Invasive plants are already abundant in several portions of the former mine site, leaving adjacent forests susceptible to their spread. Predators (e.g., raccoons, nest parasites) will also encroach further into the forest as the edges are cleared for mining. Edge effects vary significantly, depending on the site, adjacent topography and vegetation, and the species in question. The removal of 18.2 acres of woodland buffer opens the adjacent high quality forest to edge effects (Map Exhibit 4).

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[3] For example, see Hilty, J.A., W.Z. Lidicker, Jr. and A.M. Merenlender. 2006. Corridor ecology: the science and practice of linking landscapes for biodiversity conservation. Island Press, Washington DC; and Liu, J., V. Hull, A.T. Morzillo and J.A. Wiens. Sources, sinks and sustainability. Cambridge University Press, New York NY.

[4] Forman, R.T.T. et al. 2003. Road ecology: science and solutions. Island Press, Washington DC.

Microclimate Impacts. Groundcover plant life changes are expected in adjacent forests due to warming and drying following the opening of the forest edge with clearing for the mine operation.

Surface Water Impacts. While precautions are addressed in the DEIS, the potential remains for site erosion and sedimentation to Zavoral Creek and the St. Croix River. In 1970 or 1971, a significant erosion event originating from the Zavoral Mine site deposited a substantial amount of sediment in Middle Creek and the St. Croix River. This is of significant concern due to the presence of federally-listed mussel species in the St. Croix River, just downstream of the Zavoral site. Sediment-laden or warm runoff flowing to Zavoral Creek has the potential to affect the Brook Trout population.

Impacts to Shallow Groundwater. The DEIS indicates that flows are likely to increase in adjacent springs and seeps due to the greater infiltration that is expected to occur after mining is completed. These springs and seeps support Southern mesic cliff communities, Black ash seepage swamps, and trout habitat in Zavoral Creek. However, changes in water temperature (e.g., warming due to increased infiltration rates) and water chemistry (e.g., due to chloride application for dust control) was not investigated yet could adversely affect these plant communities and thermally-sensitive fish.

CONCLUSIONS

AES's investigations identified significant findings related to the site's ecological context, sensitive natural resources, potential ecological impacts, and potential mitigation strategies:

1. The proposed mine is located immediately adjacent to the St. Croix National Scenic Riverway and associated National Park easement. No buffer is proposed between the proposed mine and the easement. A portion of the site is located within a high-quality Regionally Significant Ecological Area (RSEA) extending along the St. Croix National Scenic Riverway.
2. The RSEA also is in a Conservation Corridor defined by the MN DNR. This wildlife corridor contains numerous rare plant and animal species. The proposed mine would compromise the Conservation Corridor directly by clearing 5.4 acres of native forest, increasing habitat fragmentation, and removing tree and shrub vegetation that has developed for over 30 years since mining ceased.
3. The mine will indirectly affect the adjacent high quality forests and National Park easement. Indirect effects are due to:
    a. Opening of the forest edge which allows movement into the forest by invasive shrub species (buckthorn, honeysuckle) and also mammal and birds that prey on the young and eggs of forest birds, reducing the productivity of these species;
    b. Noise, which DEIS modeling has indicated will result in perceptible change in noise levels at over a quarter mile from the mine. The resulting noise level will be perceived by forest nesting songbirds and likely result in lower density of nests in the noise-affected area;
    c. Dust and warmed air caused by the mine's microclimate, which changes the plant life of the forests adjacent to the mine at distances of up to 50m; and
    d. Visual disturbance to adjacent wildlife from vehicles and people, reducing wildlife's use of adjacent areas at varying distances depending on species.
4. The RSDD did not require the assessment of alternative mining sites, but AES believes there is justification to address alternative sites.
    a. Alternative site consideration and analysis is a standard requirement of the Minnesota Environmental Quality Board's environmental review process;

   b. The justification for not assessing alternative sites (RSDD, pg 8, "Alternative Sites") is inadequate;
   c. Numerous unencumbered deposits of sand and gravel are available to serve the metropolitan area outside the St. Croix National Scenic Riverway, associated bluffs, and MN DNR-identified RSEAs and Conservation Corridors.
5. While not pristine, the proposed mining area will eliminate 64 acres of semi-natural grasslands, woodlands and forests. Review of historical aerial photographs and topographic maps indicate that in 1938 approximately 80% of the proposed mine had been cleared for agriculture and was being cultivated. Much of this cleared area was then mined, which increased the disturbed area to approximately 90% of the proposed mine. However, the site has passively restored itself beginning over 30 years ago. This vegetation currently protects the RSEA by buffering it from traffic noise and movement, microclimate effects, and to some extent incursions by invasive plants or predators on forest-nesting birds.
6. The addition of Subalternative 3A in the most recent version of the DEIS is welcome. Shortening the active period of mining and accelerating reclamation will reduce the length of time that wildlife is displaced and edge effects are experienced by the Conservation Corridor and RSEA. However, we do not know the site's post-mining use (e.g., residential development, additional mining), which could negatively affect the Conservation Corridor and RSEA by its own direct or indirect impacts.
7. The DEIS describes erosion and stormwater runoff management for Zavoral Creek, but the proposed BMPs are not adequate for the high quality of this stream and the potential risk posed by the proposed mine. Zavoral Creek is a small creek (1-2 inches deep); therefore, it cannot absorb much pollution. Brook trout (estimated at 400+ per stream mile) are highly sensitive species, especially with regard to temperature and sediment. The 1970-1971 mass erosion event at the site underscores the site's susceptibility to erosion and the potential for significant sediment loadings to adjacent creeks and the St. Croix River.
8. The mine has the potential to permanently alter groundwater flow to high quality plant communities and the trout stream, Zavoral Creek. Mining will alter surface hydrology, infiltration rates and water chemistry. Subtle changes in water flows and chemistry can be detrimental to sensitive plant communities (e.g., Black Ash Seepage Swamps), trout and aquatic macroinvertebrates. Scott Alexander's findings will inform potential impacts to these natural resources.

RECOMMENDATIONS

AES's makes these recommendations based on its work:

1. Request that alternative mining sites be considered, as mandated by the MN EQB.
2. Review whether the mine should proceed based on the consideration of more appropriate mining sites.
3. Review whether the mine should proceed in all areas of the proposed mine footprint based on considerations of the affect on groundwater flow to Zavoral Creek and spring-fed plant communities.
4. If the mine is approved, propose a reduced mine footprint that protects the forest edges of the proposed mining area. These are the most ecologically sensitive portions of the mine. Protecting these edges would significantly benefit the site and region.
5. Restore the forest edges of the mine with natural grades and intensive tree and shrub plantings to close the forest edge within 5 years.

6. Permanently protect the forest edge with a conservation easement held by a third party that is competent to ensure monitoring and protection in perpetuity.
7. Require that the applicant specify which Potential Mitigation Measures in the DEIS will be used and what actions will be taken if the measures are not implemented appropriately.
8. Request that the Reclamation Plan:
    a. Contain greater specificity for tree and shrub plantings and performance standards;
    b. Extend the monitoring and management period to at least 5 years;
    c. Ensure funding to implement the plan and monitor the site; and
    d. Include an adaptive management plan.

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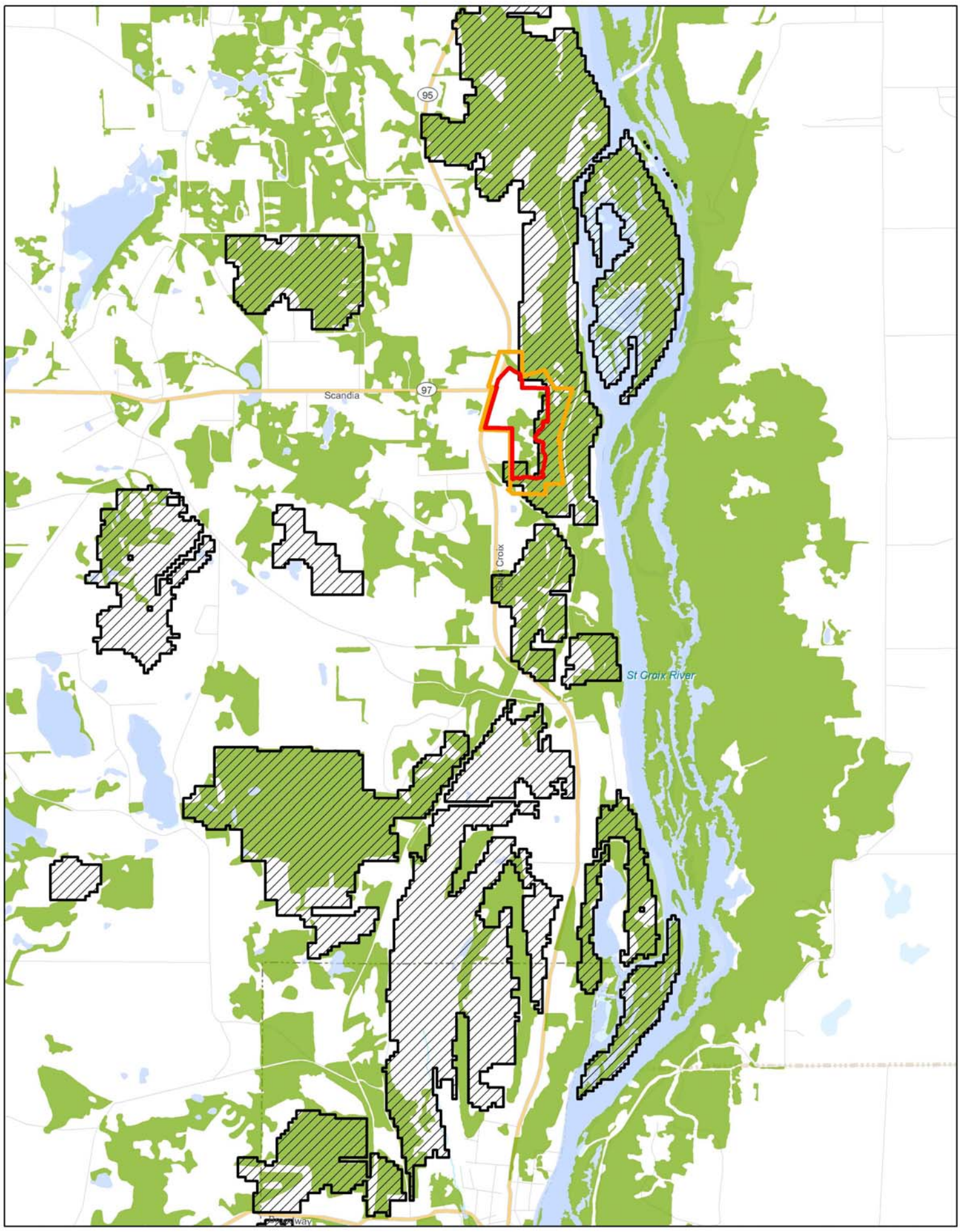
Map Exhibit 1. Regional Ecological Context – Habitats



Regional Ecological Context - Habitats

Zavoral Mining & Reclamation Project
Scandia, MN

- Property Boundary
- Proposed Mining Limit
- Regionally Significant Ecological Areas
- Forest & Woodland
- Open Water

Data Sources:
MLCCS; MN DNR; StreetMap

AES Job Number: 11-0866
Date: 3/29/2012
File Name: SiteContextHabs20120329.mxd

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952-447-1919
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Miles

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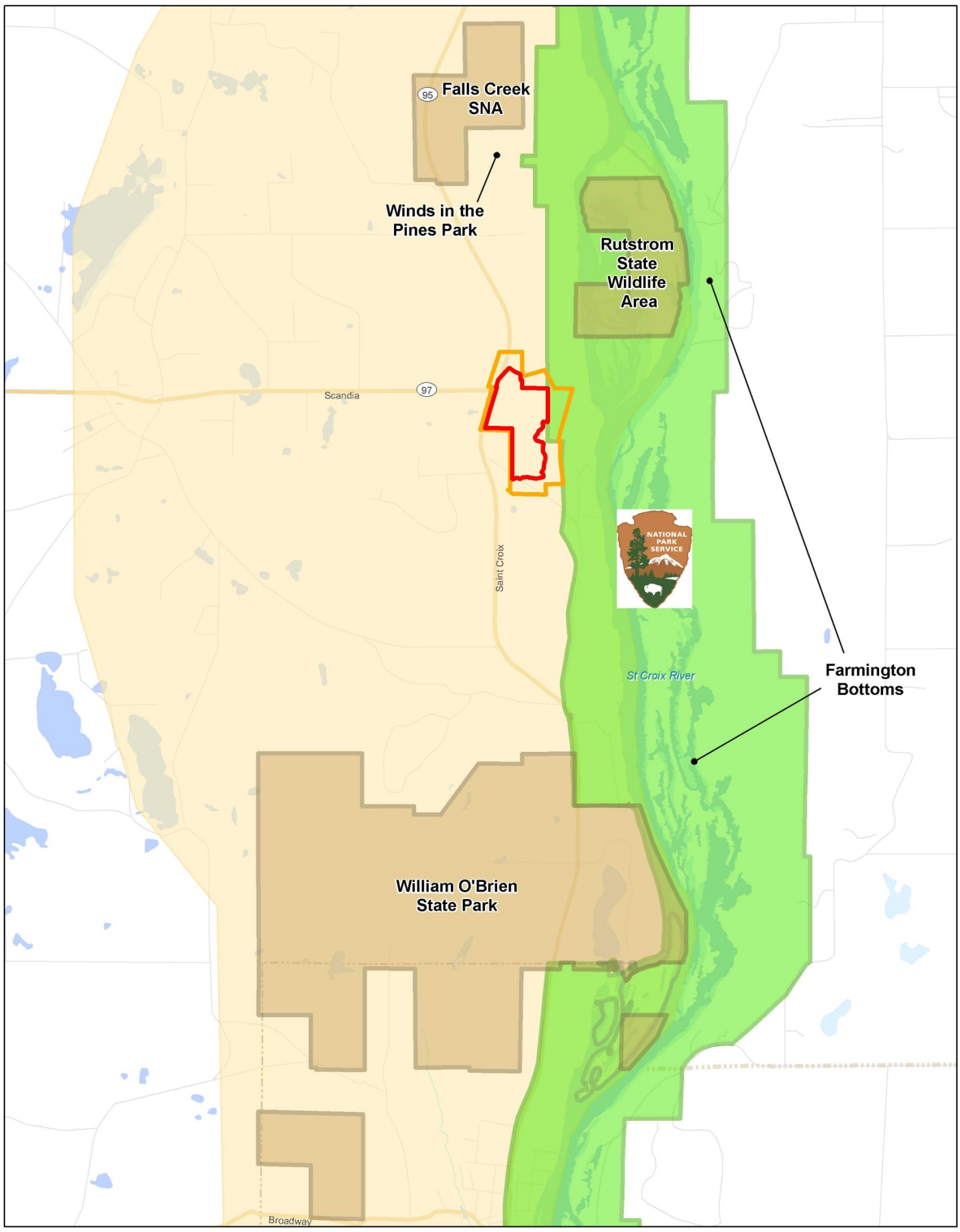
Map Exhibit 2. Regional Ecological Context – Conservation Lands



Regional Ecological Context - Conservation Lands

Zavoral Mining & Reclamation Project
Scandia, MN

- Property Boundary
- Proposed Mining Limit
- St. Croix National Scenic Riverway (National Park & Easements)
- State-Owned Land
- MN DNR Conservation Corridor
- Open Water

Data Sources:
MN DNR; NPS; StreetMap USA

AES Job Number: 11-0866
Date: 3/29/2012
File Name: SiteContextCons20120329.mxd

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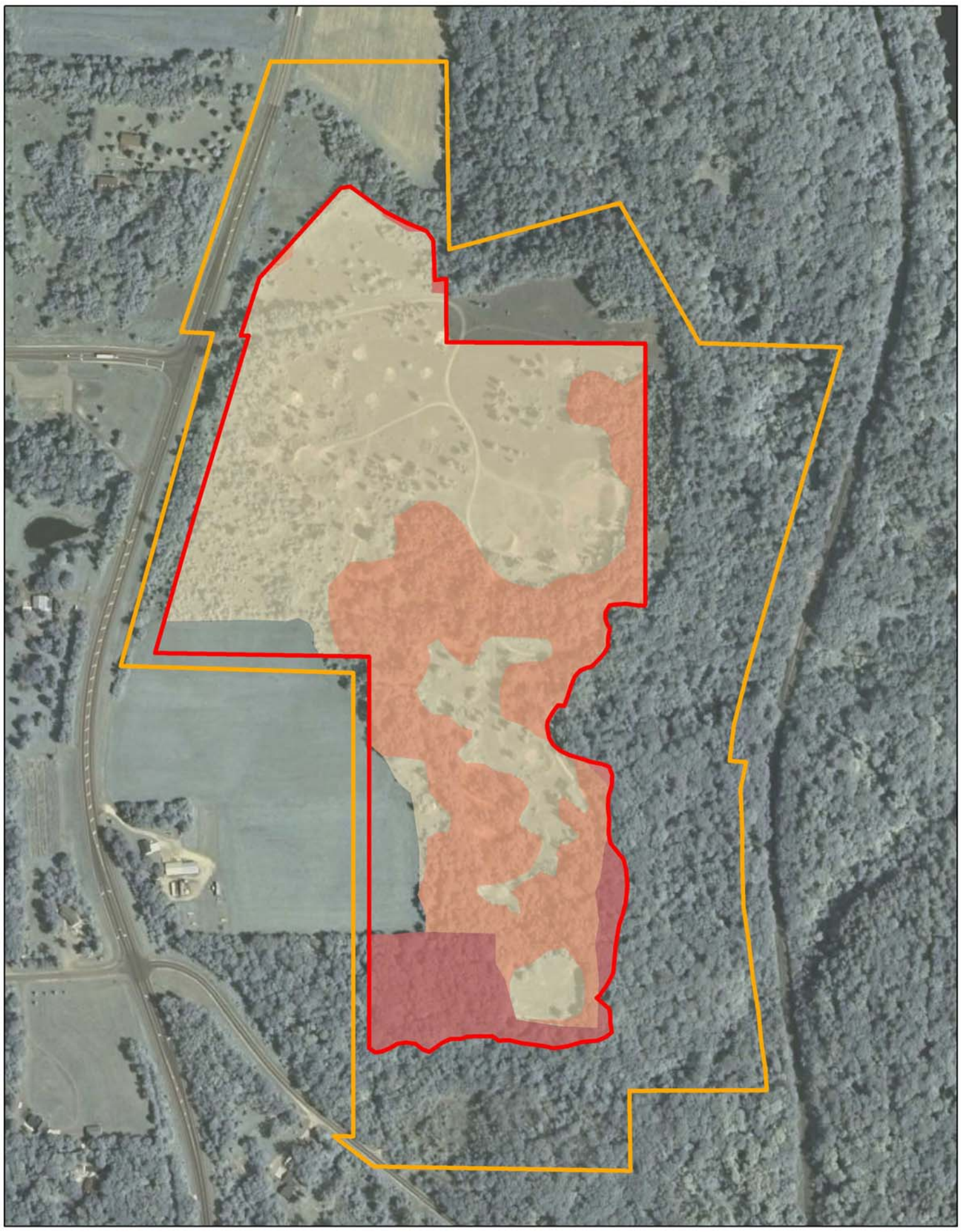
Map Exhibit 3. Forest Effects



Forest Effects

Zavoral Mining & Reclamation Project
Scandia, MN

- Property Boundary
- Proposed Mining Limit
- Proposed Removal of Native Forest (5.4 ac)
- Proposed Removal of Woodland Buffer (18.2 ac)
- Proposed Removal of Other Semi-Natural Habitat (33.6 ac)

Data Sources:
NAIP 2010 aerial photo; MLCCS

AES Job Number: 11-0866
Date: 3/29/2012
File Name: ForestEffects20120329.mxd

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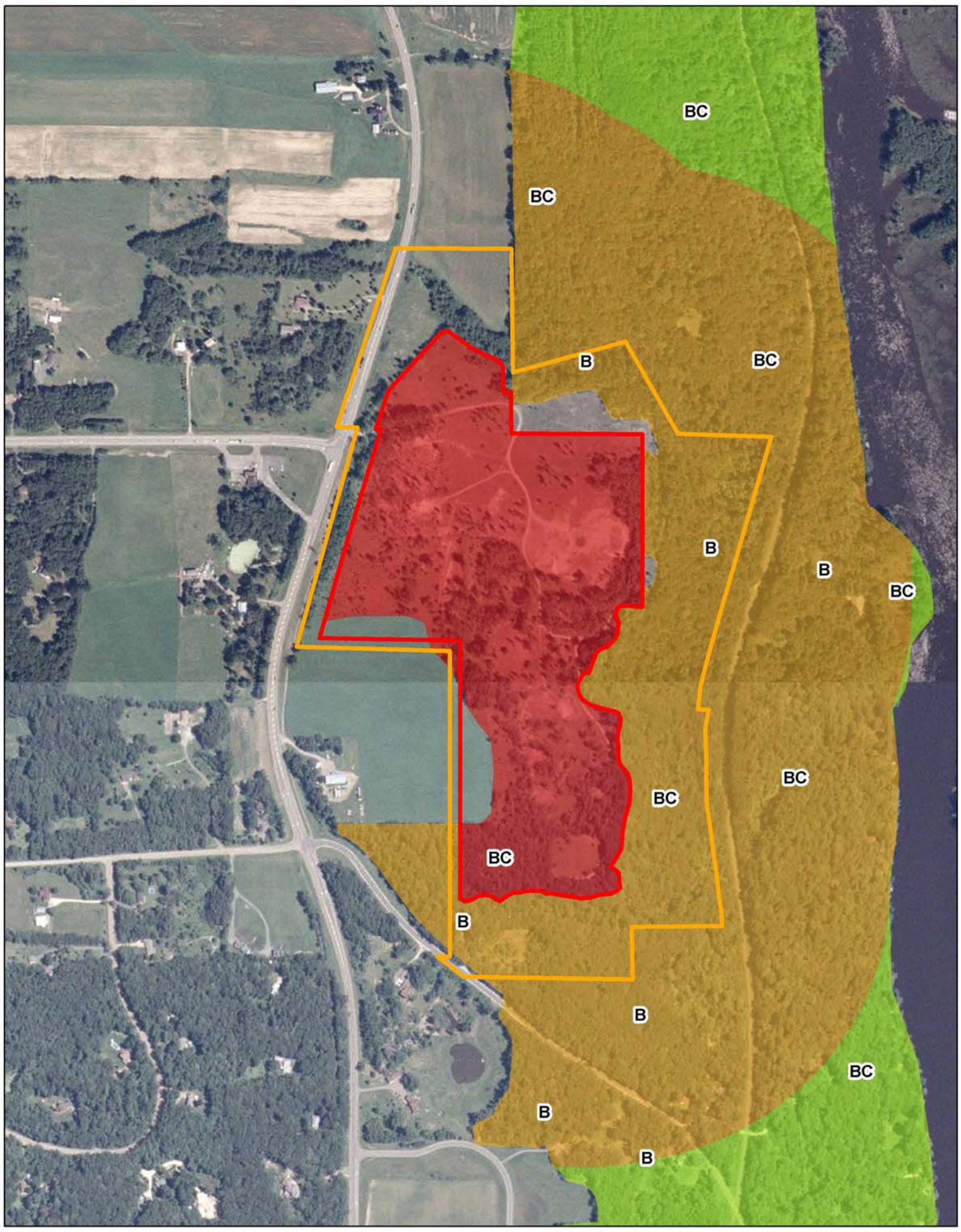
Map Exhibit 4. Edge Effects



Edge Effects

Zavoral Mining & Reclamation Project
Scandia, MN

- Property Boundary
- Proposed Mining Limit
- Direct Impacts to Corridor (57.2 ac)
- Zone of Forest Breeding Bird Impacts (172.6 ac)
- Less Affected Corridor

Note: Capital letters represent quality rank of native plant communities.

Data Sources:
NAIP 2010 aerial photo; MLCCS

AES Job Number: 11-0866
Date: 3/29/2012
File Name: EdgeEffects20120329.mxd

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Appendix A. Endangered, Threatened, Special Concern, SGCN, and Declining Bird Species in the Region around the Zavoral Mine

Scientific Name	Common Name	Name Type	Name Category	Subcategory	NHIS Database (within 5 mi. of Zavoral site)	SGCN	BBS Declining Bird Species	State Legal Status	Federal Legal Status
Microtus ochrogaster	Prairie Vole	Zoological	Vertebrate Animal	MAMMAL		X		SPC	NL
Mustela nivalis	Least Weasel	Zoological	Vertebrate Animal	MAMMAL		X		SPC	NL
Myotis septentrionalis	Northern Myotis	Zoological	Vertebrate Animal	MAMMAL	X	X		SPC	NL
Pipistrellus subflavus	Eastern Pipistrelle	Zoological	Vertebrate Animal	MAMMAL	X	X		SPC	NL
Reithrodontomys megalotis	Western Harvest Mouse	Zoological	Vertebrate Animal	MAMMAL		X		NL	NL
Spermophilus franklinii	Franklin's Ground Squirrel	Zoological	Vertebrate Animal	MAMMAL	X			NL	NL
Spilogale putorius	Eastern Spotted Skunk	Zoological	Vertebrate Animal	MAMMAL		X		THR	NL
Taxidea taxus	American Bager	Zoological	Vertebrate Animal	MAMMAL		X			
Taxidea taxus	American Badger	Zoological	Vertebrate Animal	MAMMAL		X		NL	NL
Ammodramus henslowii	Henslow's Sparrow	Zoological	Vertebrate Animal	BIRD		X		END	NL
Ammodramus savannarum	Grasshopper Sparrow	Zoological	Vertebrate Animal	BIRD		X	X	NL	NL
Anas acuta	Northern Pintail	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Anas discors	Blue-winged Teal	Zoological	Vertebrate Animal	BIRD			X		
Anas rubripes	American Black Duck	Zoological	Vertebrate Animal	BIRD			X		
Ardea herodias	Great Blue Heron	Zoological	Vertebrate Animal	BIRD			X		
Arenaria interpres	Ruddy Turnstone	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Aythya affinis	Lesser Scaup	Zoological	Vertebrate Animal	BIRD			X		
Bartramia longicauda	Upland Sandpiper	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Botaurus lentiginosus	American Bittern	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Buteo lineatus	Red-shouldered Hawk	Zoological	Vertebrate Animal	BIRD	X	X		SPC	NL
Calidris alpina	Dunlin	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Calidris fuscicollis	White-rumped Sandpiper	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Calidris pusilla	Semipalmated Sandpiper	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Caprimulgus vociferus	Whip-poor-will	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Carduelis pinus	Pine Siskin	Zoological	Vertebrate Animal	BIRD			X		
Carpodacus purpureus	Purple Finch	Zoological	Vertebrate Animal	BIRD			X		
Catharus fuscescens	Veery	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Catharus ustulatus	Swainson's Thrush	Zoological	Vertebrate Animal	BIRD			X		
Chaetura pelagica	Chimney Swift	Zoological	Vertebrate Animal	BIRD			X		
Chlidonias niger	Black Tern	Zoological	Vertebrate Animal	BIRD		X	X	NL	NL
Chordeiles minor	Common Nighthawk	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Circus cyaneus	Northern Harrier	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Cistothorus palustris	Marsh Wren	Zoological	Vertebrate Animal	BIRD		X	X	NL	NL
Cistothorus platensis	Sedge Wren	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Coccothraustes vespertinus	Evening Grosbeak	Zoological	Vertebrate Animal	BIRD			X		
Coccyzus erythropthalmus	Black-billed Cuckoo	Zoological	Vertebrate Animal	BIRD		X	X	NL	NL
Colaptes auratus	Northern Flicker	Zoological	Vertebrate Animal	BIRD			X		
Contopus cooperi	Olive-sided Flycatcher	Zoological	Vertebrate Animal	BIRD			X		
Contopus virens	Eastern Wood-pewee	Zoological	Vertebrate Animal	BIRD		X	X	NL	NL
Cygnus buccinator	Trumpeter Swan	Zoological	Vertebrate Animal	BIRD		X		THR	NL
Dendroica cerulea	Cerulean Warbler	Zoological	Vertebrate Animal	BIRD	X	X		SPC	NL

Scientific Name	Common Name	Name Type	Name Category	Subcategory	NHIS Database (within 5 mi. of Zavoral site)	SGCN	BBS Declining Bird Species	State Legal Status	Federal Legal Status
Dolichonyx oryzivorus	Bobolink	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Empidonax minimus	Least Flycatcher	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Empidonax traillii	Willow Flycatcher	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Empidonax virescens	Acadian Flycatcher	Zoological	Vertebrate Animal	BIRD		X		SPC	NL
Falco peregrinus	Peregrine Falcon	Zoological	Vertebrate Animal	BIRD		X		THR	NL
Falco sparverius	American Kestrel	Zoological	Vertebrate Animal	BIRD			X		
Fulica americana	American Coot	Zoological	Vertebrate Animal	BIRD			X		
Gallinago gallinago	Common Snipe	Zoological	Vertebrate Animal	BIRD			X		
Gallinula chloropus	Common Moorhen	Zoological	Vertebrate Animal	BIRD		X		SPC	NL
Gavia immer	Common Loon	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Haliaeetus leucocephalus	Bald Eagle	Zoological	Vertebrate Animal	BIRD	X	X		SPC	THR
Hylocichla mustelina	Wood Thrush	Zoological	Vertebrate Animal	BIRD		X	X	NL	NL
Icterus galbula	Baltimore Oriole	Zoological	Vertebrate Animal	BIRD			X		
Ixobrychus exilis	Least Bittern	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Lanius ludovicianus	Loggerhead Shrike	Zoological	Vertebrate Animal	BIRD		X	X	THR	NL
Limnodromus griseus	Short-billed Dowitcher	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Limosa haemastica	Hudsonian Godwit	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Melanerpes erythrocephalus	Red-headed Woodpecker	Zoological	Vertebrate Animal	BIRD		X	X	NL	NL
Melospiza georgiana	Swamp Sparrow	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Mergus serrator	Red-breasted Merganser	Zoological	Vertebrate Animal	BIRD			X		
Nycticorax nycticorax	Black-crowned Night-heron	Zoological	Vertebrate Animal	BIRD		X	X	NL	NL
Parula americana	Northern Parula	Zoological	Vertebrate Animal	BIRD			X		
Phalaropus tricolor	Wilson's Phalarope	Zoological	Vertebrate Animal	BIRD			X		
Pheucticus ludovicianus	Rose-breasted Grosbeak	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Pluvialis dominica	American Golden-plover	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Podiceps grisegena	Red-necked Grebe	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Progne subis	Purple Martin	Zoological	Vertebrate Animal	BIRD			X		
Protonotaria citrea	Prothonotary Warbler	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Rallus limicola	Virginia Rail	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Recurvirostra americana	American Avocet	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Sayornis phoebe	Eastern Phoebe	Zoological	Vertebrate Animal	BIRD			X		
Scolopax minor	American Woodcock	Zoological	Vertebrate Animal	BIRD		X	X	NL	NL
Seiurus aurocapillus	Ovenbird	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Seiurus motacilla	Louisiana Waterthrush	Zoological	Vertebrate Animal	BIRD	X	X		SPC	NL
Setophaga magnolia	Magnolia Warbler	Zoological	Vertebrate Animal	BIRD			X		
Setophaga virens	Black-th. Green Warbler	Zoological	Vertebrate Animal	BIRD			X		
Sphyrapicus varius	Yellow-bellied Sapsucker	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Spiza americana	Dickcissel	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Spiza americana	Dickcissel	Zoological	Vertebrate Animal	BIRD			X		
Spizella pusilla	Field Sparrow	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Stelgidopteryx serripennis	Northern Rough-winged Swallow	Zoological	Vertebrate Animal	BIRD		X	X	NL	NL
Sterna forsteri	Forster's Tern	Zoological	Vertebrate Animal	BIRD		X		SPC	NL
Sturnella magna	Eastern Meadowlark	Zoological	Vertebrate Animal	BIRD		X		NL	NL

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Toxostoma rufum	Brown Thrasher	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Tringa melanoleuca	Greater Yellowlegs	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Tringa semipalmata	Willet	Zoological	Vertebrate Animal	BIRD			X		
Troglodytes troglodytes	Winter Wren	Zoological	Vertebrate Animal	BIRD		X	X	NL	NL
Tryngites subruficollis	Buff-breasted Sandpiper	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Tyrannus tyrannus	Eastern Kingbird	Zoological	Vertebrate Animal	BIRD			X		
Tyrannus verticalis	Western Kingbird	Zoological	Vertebrate Animal	BIRD			X		
Vermivora pinus	Blue-winged Warbler	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Vireo bellii	Bell's Vireo	Zoological	Vertebrate Animal	BIRD		X		NL	NL
Wilsonia canadensis	Canada Warbler	Zoological	Vertebrate Animal	BIRD			X		
Wilsonia citrina	Hooded Warbler	Zoological	Vertebrate Animal	BIRD	X	X		SPC	NL
Acipenser fulvescens	Lake Sturgeon	Zoological	Vertebrate Animal	FISH	X	X		SPC	NL
Alosa chrysochloris	Skipjack Herring	Zoological	Vertebrate Animal	FISH		X		SPC	NL
Ammocrypta asprella	Crystal Darter	Zoological	Vertebrate Animal	FISH		X		SPC	NL
Ammocrypta clara	Western Sand Darter	Zoological	Vertebrate Animal	FISH		X		NL	NL
Anguilla rostrata	American Eel	Zoological	Vertebrate Animal	FISH		X		NL	NL
Aphredoderus sayanus	Pirate Perch	Zoological	Vertebrate Animal	FISH		X		SPC	NL
Campostoma oligolepis	Largescale Stoneroller	Zoological	Vertebrate Animal	FISH		X		NL	NL
Cycleptus elongatus	Blue Sucker	Zoological	Vertebrate Animal	FISH	X	X		SPC	NL
Etheostoma asprigene	Mud Darter	Zoological	Vertebrate Animal	FISH		X		NL	NL
Etheostoma chlorosoma	Bluntnose Darter	Zoological	Vertebrate Animal	FISH		X		NL	NL
Hybognathus nuchalis	Mississippi Silvery Minnow	Zoological	Vertebrate Animal	FISH		X		NL	NL
Ichthyomyzon gagei	Southern Brook Lamprey	Zoological	Vertebrate Animal	FISH	X	X		SPC	NL
Ictiobus niger	Black Buffalo	Zoological	Vertebrate Animal	FISH		X		SPC	NL
Lampetra appendix	American Brook Lamprey	Zoological	Vertebrate Animal	FISH		X		NL	NL
Lepomis gulosus	Warmouth	Zoological	Vertebrate Animal	FISH		X		NL	NL
Lepomis megalotis	Longear Sunfish	Zoological	Vertebrate Animal	FISH		X		NL	NL
Macrhybopsis aestivalis	speckled chub	Zoological	Vertebrate Animal	FISH		X		NL	NL
Moxostoma carinatum	River Redhorse	Zoological	Vertebrate Animal	FISH		X		NL	NL
Moxostoma valenciennesi	Greater Redhorse	Zoological	Vertebrate Animal	FISH		X		NL	NL
Notropis amnis	Pallid Shiner	Zoological	Vertebrate Animal	FISH		X		SPC	NL
Notropis anogenus	Pugnose Shiner	Zoological	Vertebrate Animal	FISH		X		SPC	NL
Opsopoeodus emiliae	Pugnose Minnow	Zoological	Vertebrate Animal	FISH	X	X		NL	NL
Percina evides	Gilt Darter	Zoological	Vertebrate Animal	FISH	X	X		SPC	NL
Polyodon spathula	Paddlefish	Zoological	Vertebrate Animal	FISH		X		THR	NL
Scaphirhynchus platorynchus	Shovelnose Sturgeon	Zoological	Vertebrate Animal	FISH		X		NL	NL
Apalone mutica	Smooth Softshell	Zoological	Vertebrate Animal	REPTILE	X	X		SPC	NL
Chelydra serpentina	Common Snapping Turtle	Zoological	Vertebrate Animal	REPTILE		X		SPC	NL
Clemmys insculpta	Wood Turtle	Zoological	Vertebrate Animal	REPTILE	X	X		THR	NL
Cnemidophorus sexlineatus	Six-lined Racerunner	Zoological	Vertebrate Animal	REPTILE		X		NL	NL
Coluber constrictor	Eastern Racer	Zoological	Vertebrate Animal	REPTILE		X		SPC	NL
Crotalus horridus	Timber Rattlesnake	Zoological	Vertebrate Animal	REPTILE		X		THR	NL
Elaphe vulpina	Western Fox Snake	Zoological	Vertebrate Animal	REPTILE	X			NL	NL

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Elaphe vulpina	Eastern Fox Snake	Zoological	Vertebrate Animal	REPTILE		X		NL	NL
Emydoidea blandingii	Blanding's Turtle	Zoological	Vertebrate Animal	REPTILE	X	X		THR	NL
Eumeces fasciatus	Five-lined Skink	Zoological	Vertebrate Animal	REPTILE		X		SPC	NL
Heterodon nasicus	Western Hognose Snake	Zoological	Vertebrate Animal	REPTILE		X		SPC	NL
Heterodon platirhinos	Eastern Hognose Snake	Zoological	Vertebrate Animal	REPTILE		X		NL	NL
Lampropeltis triangulum	Milk Snake	Zoological	Vertebrate Animal	REPTILE		X		NL	NL
Liochlorophis vernalis	Smooth Green Snake	Zoological	Vertebrate Animal	REPTILE		X		NL	NL
Pituophis catenifer	Gopher Snake	Zoological	Vertebrate Animal	REPTILE		X		SPC	NL
Acris crepitans	Northern Cricket Frog	Zoological	Vertebrate Animal	AMPHIBIAN		X		END	NL
Hemidactylium scutatum	Four-toed Salamander	Zoological	Vertebrate Animal	AMPHIBIAN		X		SPC	NL
Necturus maculosus	Common Mudpuppy	Zoological	Vertebrate Animal	AMPHIBIAN		X		NL	NL
Marpissa grata	A Jumping Spider	Zoological	Invertebrate Animal	SPIDER		X		SPC	NL
Metaphidippus arizonensis	A Jumping Spider	Zoological	Invertebrate Animal	SPIDER		X		SPC	NL
Paradamoetas fontana	A Jumping Spider	Zoological	Invertebrate Animal	SPIDER		X		SPC	NL
Aflexia rubranura	Red Tailed Prairie Leafhopper	Zoological	Invertebrate Animal	INVERTEBRATE		X		SPC	NL
Asynarchus rossi	A Caddisfly	Zoological	Invertebrate Animal	INVERTEBRATE		X		SPC	NL
Atrytone arogos	Arogos Skipper	Zoological	Invertebrate Animal	INVERTEBRATE		X		SPC	NL
Cicindela patruela patruela	A Tiger Beetle	Zoological	Invertebrate Animal	INVERTEBRATE		X		SPC	NL
Epidemia epixanthe michiganensis	Bog Copper	Zoological	Invertebrate Animal	INVERTEBRATE		X		NL	NL
Erynnis persius	Persius Duskywing	Zoological	Invertebrate Animal	INVERTEBRATE		X		END	NL
Euphyes bimacula illinois	Two-spotted Skipper	Zoological	Invertebrate Animal	INVERTEBRATE		X		NL	NL
Gomphus viridifrons	Green-faced Clubtail	Zoological	Invertebrate Animal	INVERTEBRATE		X		NL	NL
Hesperia leonardus leonardus	Leonard's Skipper	Zoological	Invertebrate Animal	INVERTEBRATE		X		SPC	NL
Lycaena epixanthe michiganensis	Bog Copper	Zoological	Invertebrate Animal	INVERTEBRATE	X				
Ophiogomphus susbehcha	St. Croix Snaketail	Zoological	Invertebrate Animal	INVERTEBRATE	X	X		SPC	NL
Papaipema beeriana	Blazing Star Stem Borer	Zoological	Invertebrate Animal	INVERTEBRATE		X		NL	NL
Speyeria idalia	Regal Fritillary	Zoological	Invertebrate Animal	INVERTEBRATE		X		SPC	NL
Actinonaias ligamentina	Mucket mussel	Zoological	Invertebrate Animal	MOLLUSC	X	X		THR	NL
Alasmidonta marginata	Elktoe	Zoological	Invertebrate Animal	MOLLUSC	X	X		THR	NL
Arcidens confragosus	Rock Pocketbook	Zoological	Invertebrate Animal	MOLLUSC		X		END	NL
Cumberlandia monodonta	Spectaclecase	Zoological	Invertebrate Animal	MOLLUSC	X	X		THR	CAND
Cyclonaias tuberculata	Purple Wartyback	Zoological	Invertebrate Animal	MOLLUSC	X	X		THR	NL
Ellipsaria lineolata	Butterfly	Zoological	Invertebrate Animal	MOLLUSC	X	X		THR	NL
Elliptio crassidens	Elephant-ear	Zoological	Invertebrate Animal	MOLLUSC	X	X		END	NL
Elliptio dilatata	Spike	Zoological	Invertebrate Animal	MOLLUSC	X	X		SPC	NL
Epioblasma triquetra	Snuffbox	Zoological	Invertebrate Animal	MOLLUSC	X	X		THR	NL
Fusconaia ebena	Ebonyshell	Zoological	Invertebrate Animal	MOLLUSC	X	X		END	NL
Lampsilis higginsi	Higgins Eye	Zoological	Invertebrate Animal	MOLLUSC	X	X		END	END
Lampsilis teres	Yellow Sandshell	Zoological	Invertebrate Animal	MOLLUSC		X		END	NL
Lasmigona costata	Fluted-shell	Zoological	Invertebrate Animal	MOLLUSC	X	X		SPC	NL
Ligumia recta	Black Sandshell	Zoological	Invertebrate Animal	MOLLUSC	X	X		SPC	NL
Megalonaias nervosa	Washboard	Zoological	Invertebrate Animal	MOLLUSC		X		THR	NL
Obovaria olivaria	Hickorynut	Zoological	Invertebrate Animal	MOLLUSC	X	X		SPC	NL

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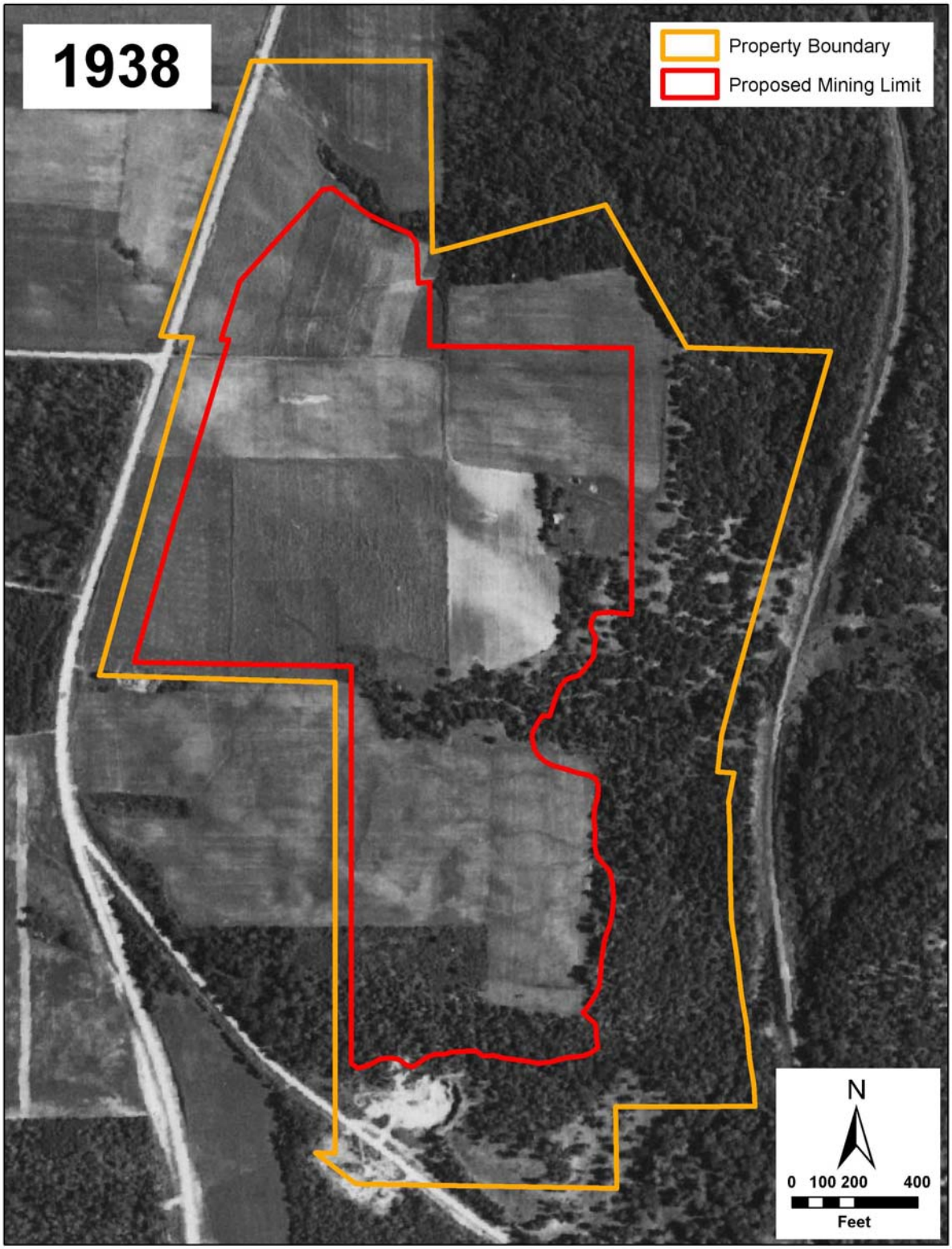
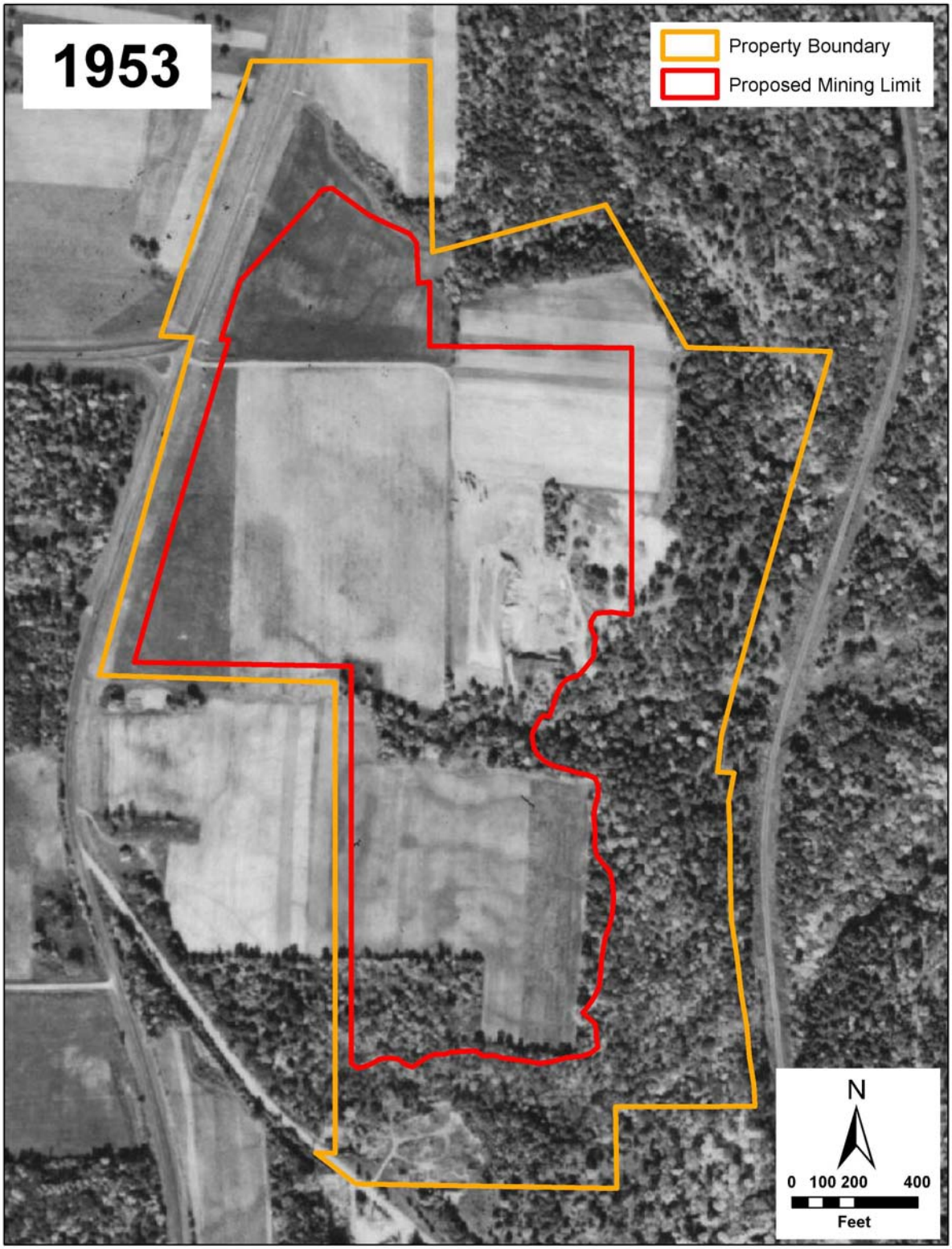
Plethobasus cyphyus	Sheepnose	Zoological	Invertebrate Animal	MOLLUSC		X		END	CAND
Pleurobema coccineum	Round Pigtoe	Zoological	Invertebrate Animal	MOLLUSC	X	X		THR	NL
Quadrula fragosa	Winged Mapleleaf	Zoological	Invertebrate Animal	MOLLUSC	X	X		END	END
Quadrula metanevra	Monkeyface	Zoological	Invertebrate Animal	MOLLUSC	X	X		THR	NL
Quadrula nodulata	Wartyback	Zoological	Invertebrate Animal	MOLLUSC		X		END	NL
Simpsonaias ambigua	Salamander Mussel	Zoological	Invertebrate Animal	MOLLUSC	X	X		THR	NL
Tritogonia verrucosa	Pistolgrip	Zoological	Invertebrate Animal	MOLLUSC	X	X		THR	NL
Truncilla donaciformis	Fawnsfoot	Zoological	Invertebrate Animal	MOLLUSC	X	X		NL	NL
Venustaconcha ellipsiformis	Ellipse	Zoological	Invertebrate Animal	MOLLUSC		X		THR	NL
Bat Colony	Bat Concentration	Zoological	Animal Assemblage	NA	X				
Colonial Waterbird Nesting Area	Colonial Waterbird Nesting Site	Zoological	Animal Assemblage	NA	X				
Freshwater Mussel Concentration Area	Mussel Sampling Site	Zoological	Animal Assemblage	NA	X				
Besseya bullii	Kitten-tails	Botanical	Vascular Plant	NA	X				
Botrychium matricariifolium	Matricary Grapefern	Botanical	Vascular Plant	NA	X				
Botrychium oneidense	Blunt-lobed Grapefern	Botanical	Vascular Plant	NA	X				
Botrychium simplex	Least Moonwort	Botanical	Vascular Plant	NA	X				
Carex typhina	Cattail Sedge	Botanical	Vascular Plant	NA	X				
Cephalanthus occidentalis	Buttonbush	Botanical	Vascular Plant	NA	X				
Desmodium nudiflorum	Stemless Tick-trefoil	Botanical	Vascular Plant	NA	X				
Echinochloa walteri	Walter's Barnyard Grass	Botanical	Vascular Plant	NA	X				
Fimbristylis autumnalis	Autumn Fimbristylis	Botanical	Vascular Plant	NA	X				
Hieracium longipilum	Long-bearded Hawkweed	Botanical	Vascular Plant	NA	X				
Hydrocotyle americana	American Water-pennywort	Botanical	Vascular Plant	NA	X				
Lycopus virginicus	Virginia Water Horehound	Botanical	Vascular Plant	NA	X				
Panax quinquefolius	American Ginseng	Botanical	Vascular Plant	NA	X				
Platanthera flava var. herbiola	Tubercled Rein-orchid	Botanical	Vascular Plant	NA	X				
Poa paludigena	Bog Bluegrass	Botanical	Vascular Plant	NA	X				
Scirpus georgianus	Georgia Bulrush	Botanical	Vascular Plant	NA	X				
Black Ash - (Red Maple) Seepage Swamp Type	Black Ash - (Red Maple) Seepage Swamp	Ecological	Terrestrial Community	NA	X				
Dry Bedrock Bluff Prairie (Southern) Type	Dry Bedrock Bluff Prairie (Southern)	Ecological	Terrestrial Community	NA	X				
Gravel/Cobble Beach (River) Type	Gravel/cobble Beach (River)	Ecological	Terrestrial Community	NA	X				
Lake bed	Lake Bed	Ecological	Terrestrial Community	NA	X				
Native Plant Community, Undetermined Class	Native Plant Community, Undetermined Class	Ecological	Terrestrial Community	NA	X				
Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest Type	Red Oak - Sugar Maple - Basswood - (Bluebead Lily) Forest	Ecological	Terrestrial Community	NA	X				
Sand Beach (Inland Lake) Type	Sand Beach (Inland Lake)	Ecological	Terrestrial Community	NA	X				
Seepage Meadow/Carr; Tussock Sedge Subtype	Seepage Meadow/Carr, Tussock Sedge Subtype	Ecological	Terrestrial Community	NA	X				
Silver Maple - (Virginia Creeper) Floodplain Forest Type	Silver Maple - (Virginia Creeper) Floodplain Forest	Ecological	Terrestrial Community	NA	X				
Southern Wet Ash Swamp Class	Southern Wet Ash Swamp	Ecological	Terrestrial Community	NA	X				
Spikerush - Bur Reed Marsh (Northern) Type	Spikerush - Bur Reed Marsh (Northern)	Ecological	Terrestrial Community	NA	X				

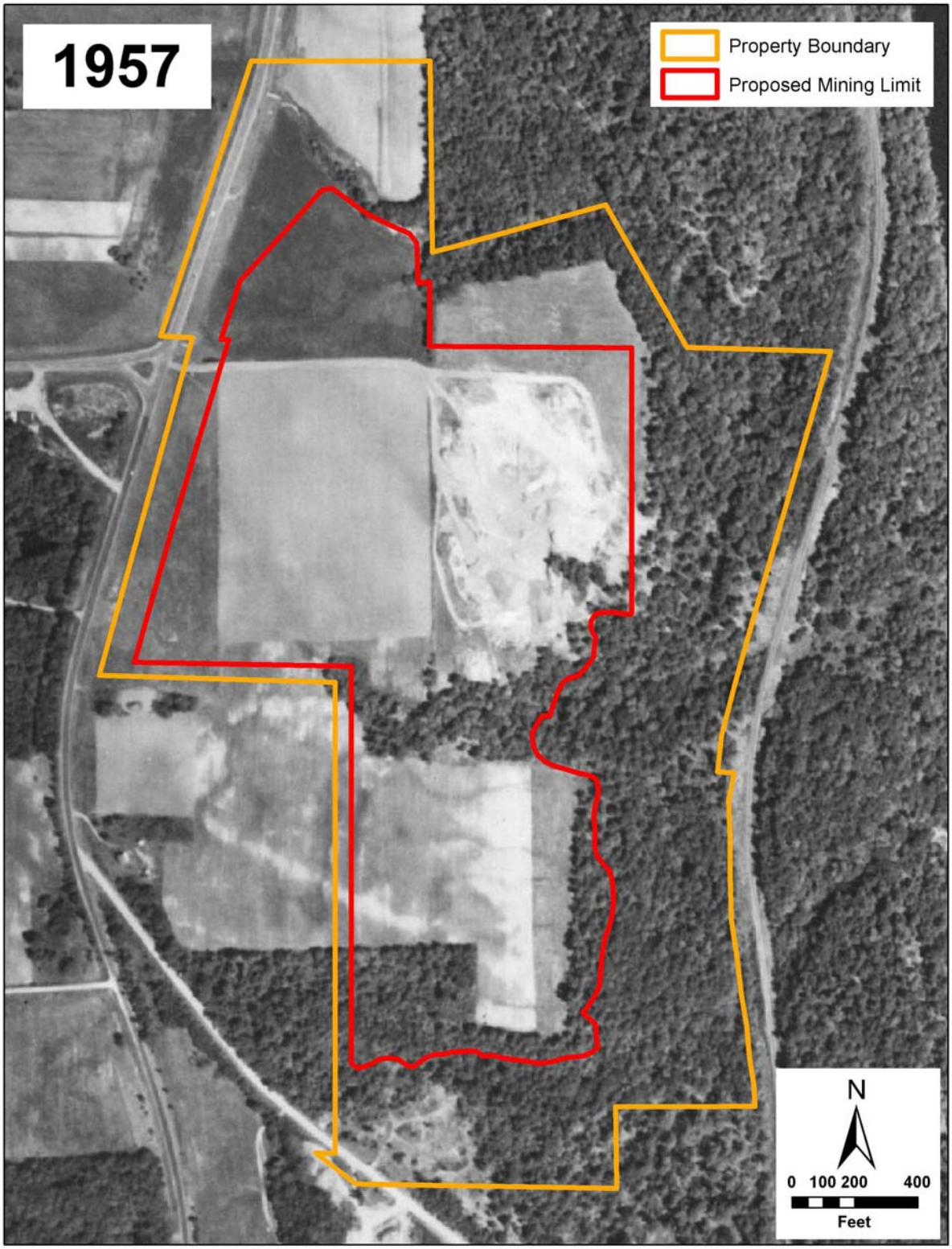
Scientific Name	Common Name	Name Type	Name Category	Subcategory	NHIS Database (within 5 mi. of Zavoral site)	SGCN	BBS Declining Bird Species	State Legal Status	Federal Legal Status
Tamarack Swamp (Southern) Type	Tamarack Swamp (Southern)	Ecological	Terrestrial Community	NA	X				

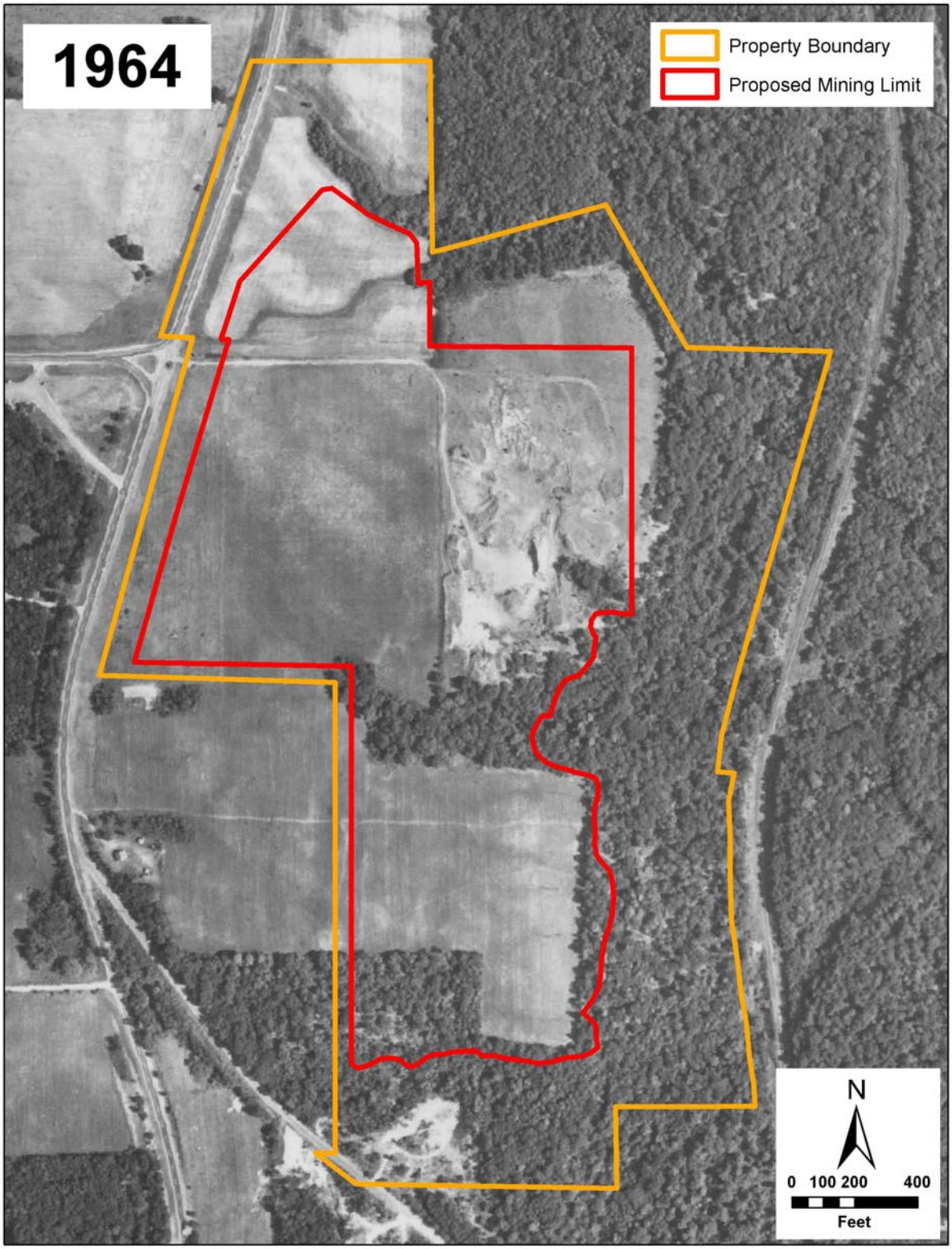
Notes:
NHIS = Natural Heritage Information System (MNDNR)
SGCN = Species of Greatest Conservation Need
BBS = Breeding Bird Survey
END = Endangered
THR = Threatened
SPC = Special Concern
CAND = candidate species (under consideration)
NL = not listed

Appendix B. Historical Aerial Photographs




1953
Property Boundary
Proposed Mining Limit
N
0 100 200 400
Feet


1957
Property Boundary
Proposed Mining Limit
N
0 100 200 400
Feet


1964
Property Boundary
Proposed Mining Limit
N
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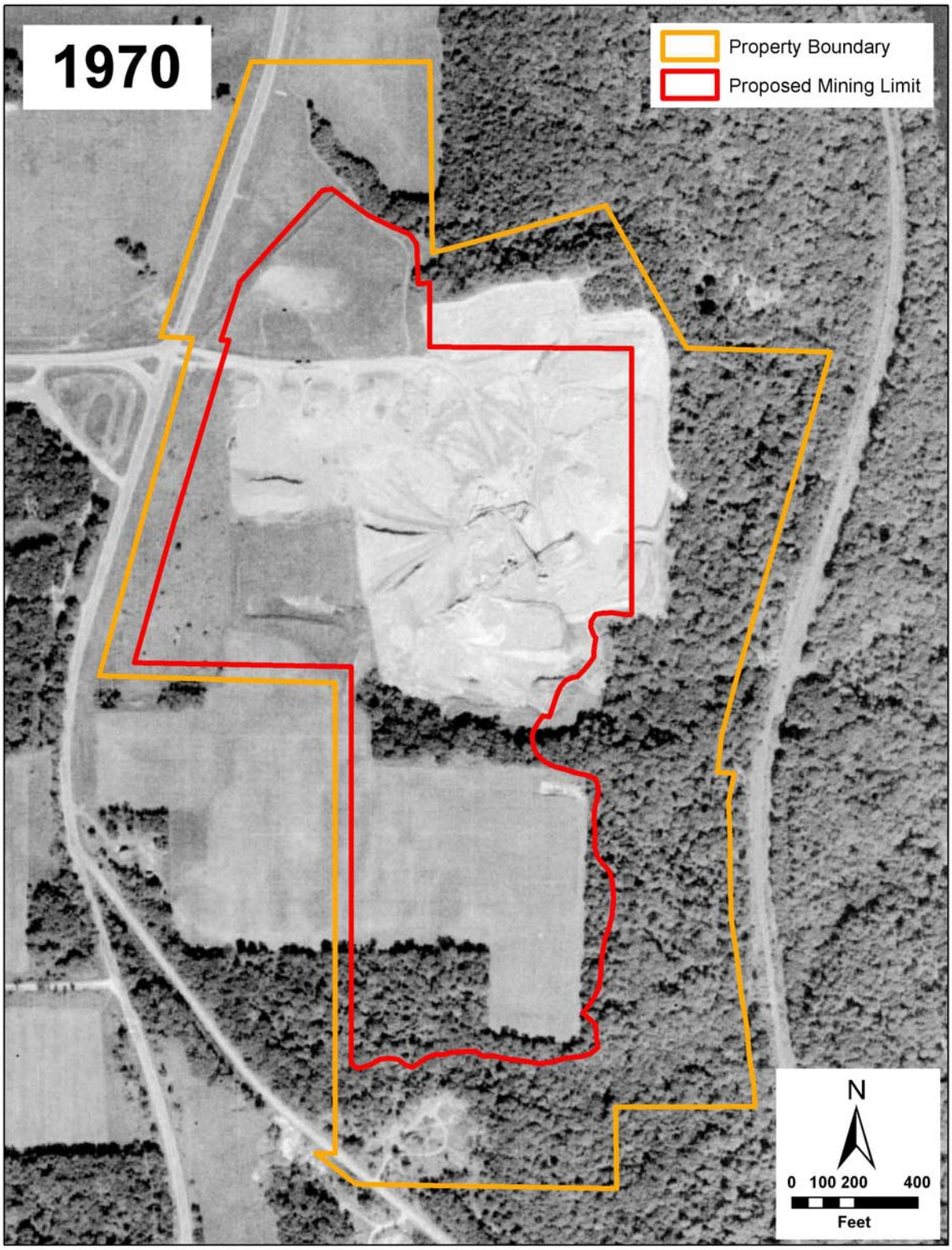
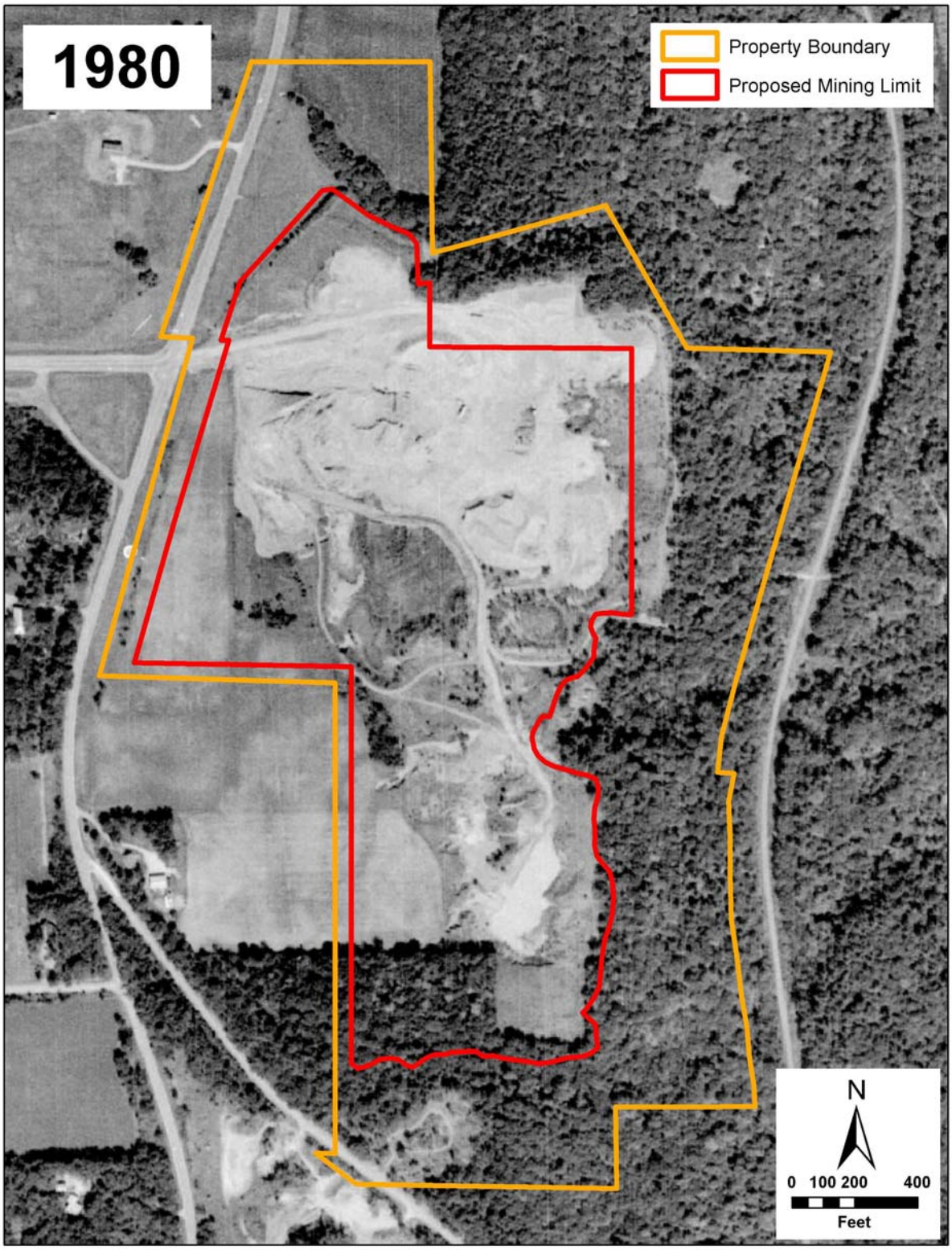
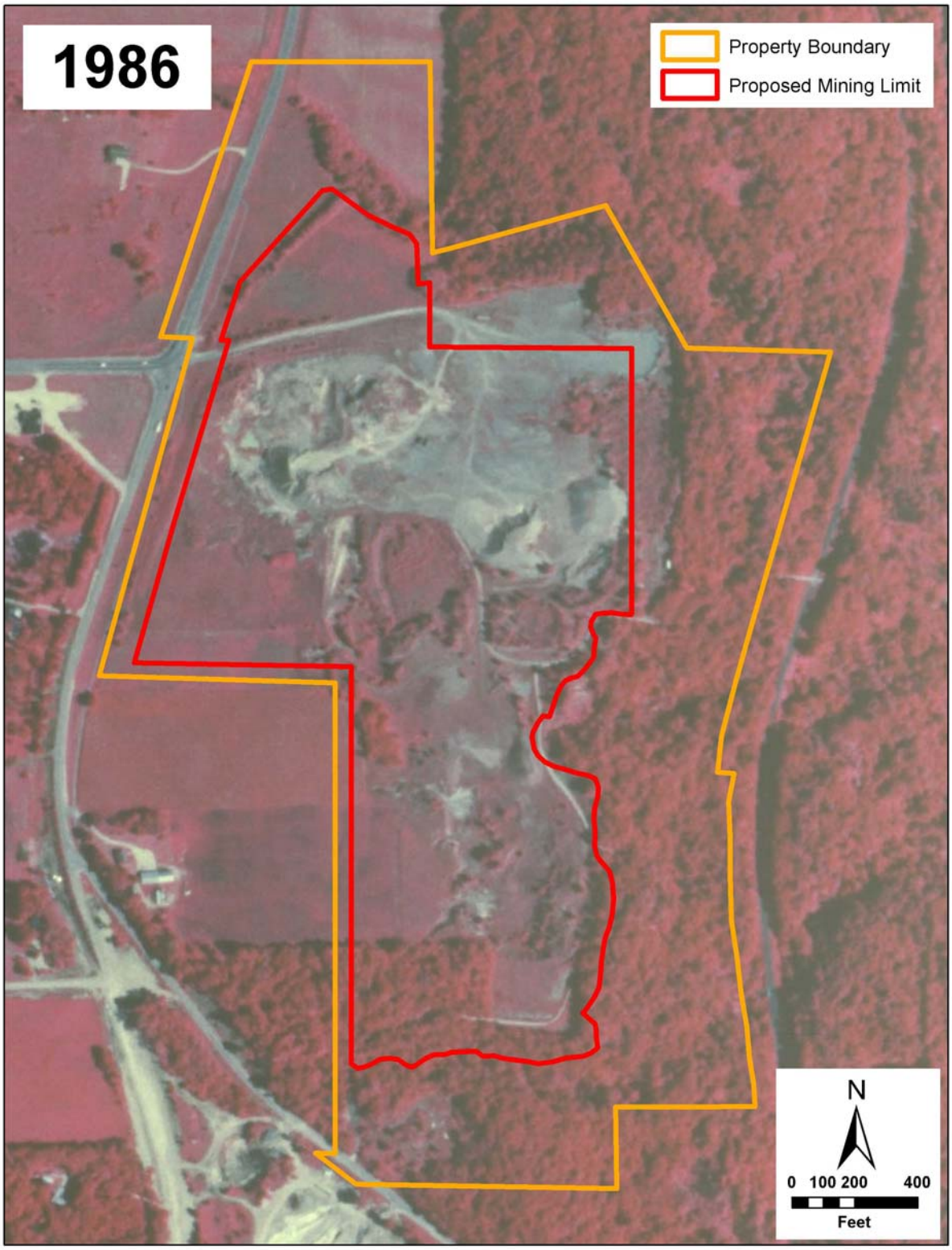
Feet


1970
Property Boundary
Proposed Mining Limit
N
0 100 200 400
Feet


1980
Property Boundary
Proposed Mining Limit
N
0 100 200 400
Feet


1986
Property Boundary
Proposed Mining Limit
N
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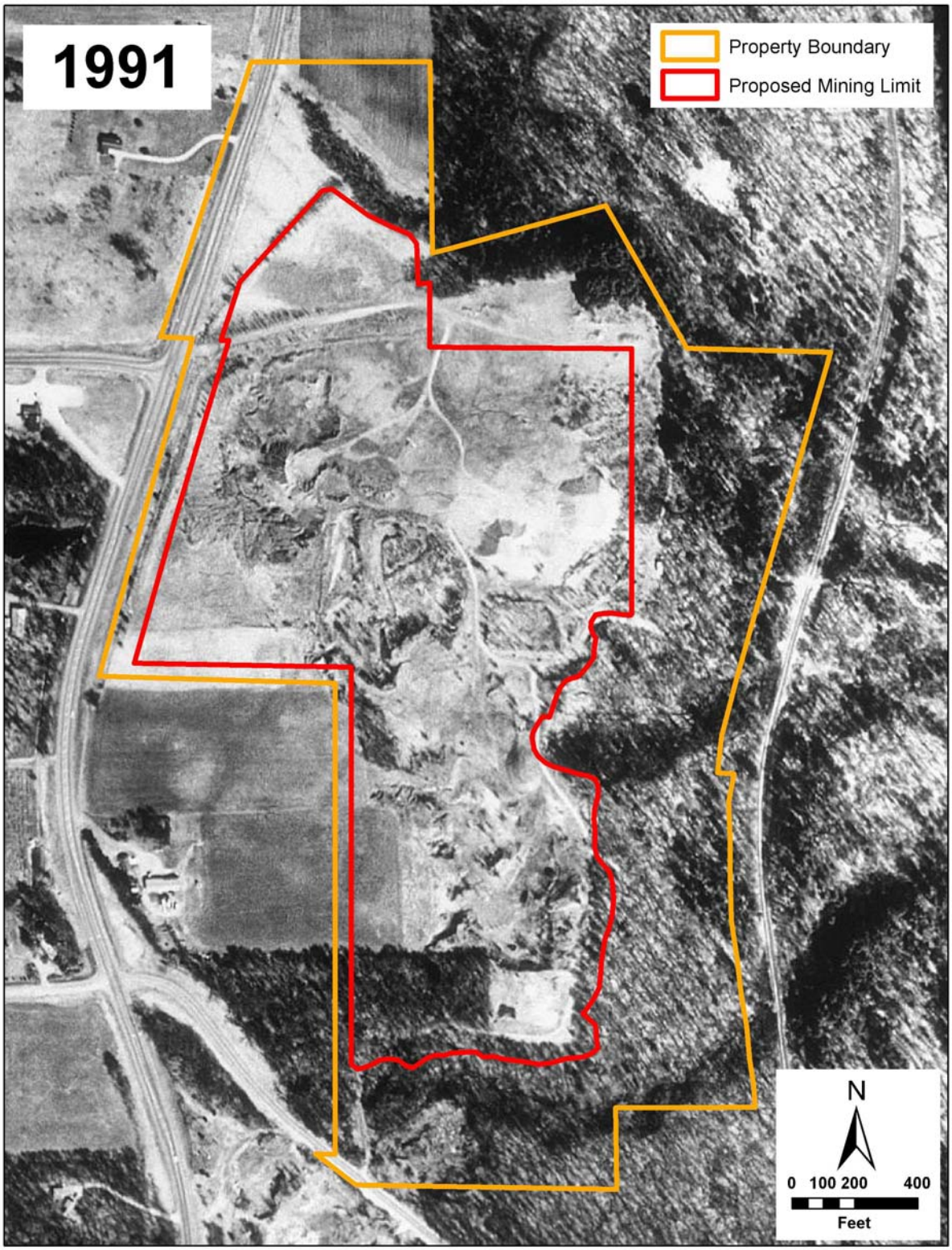
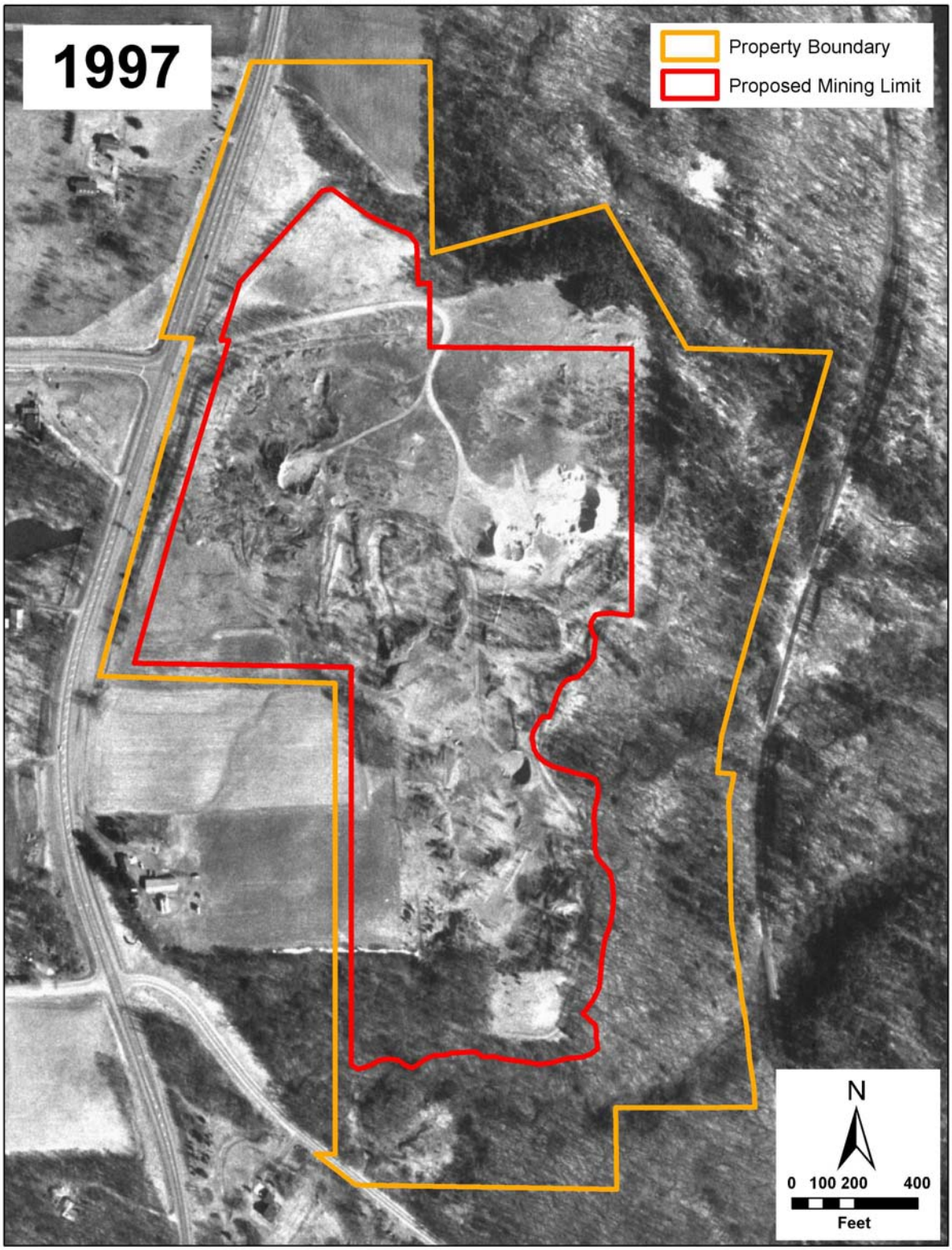
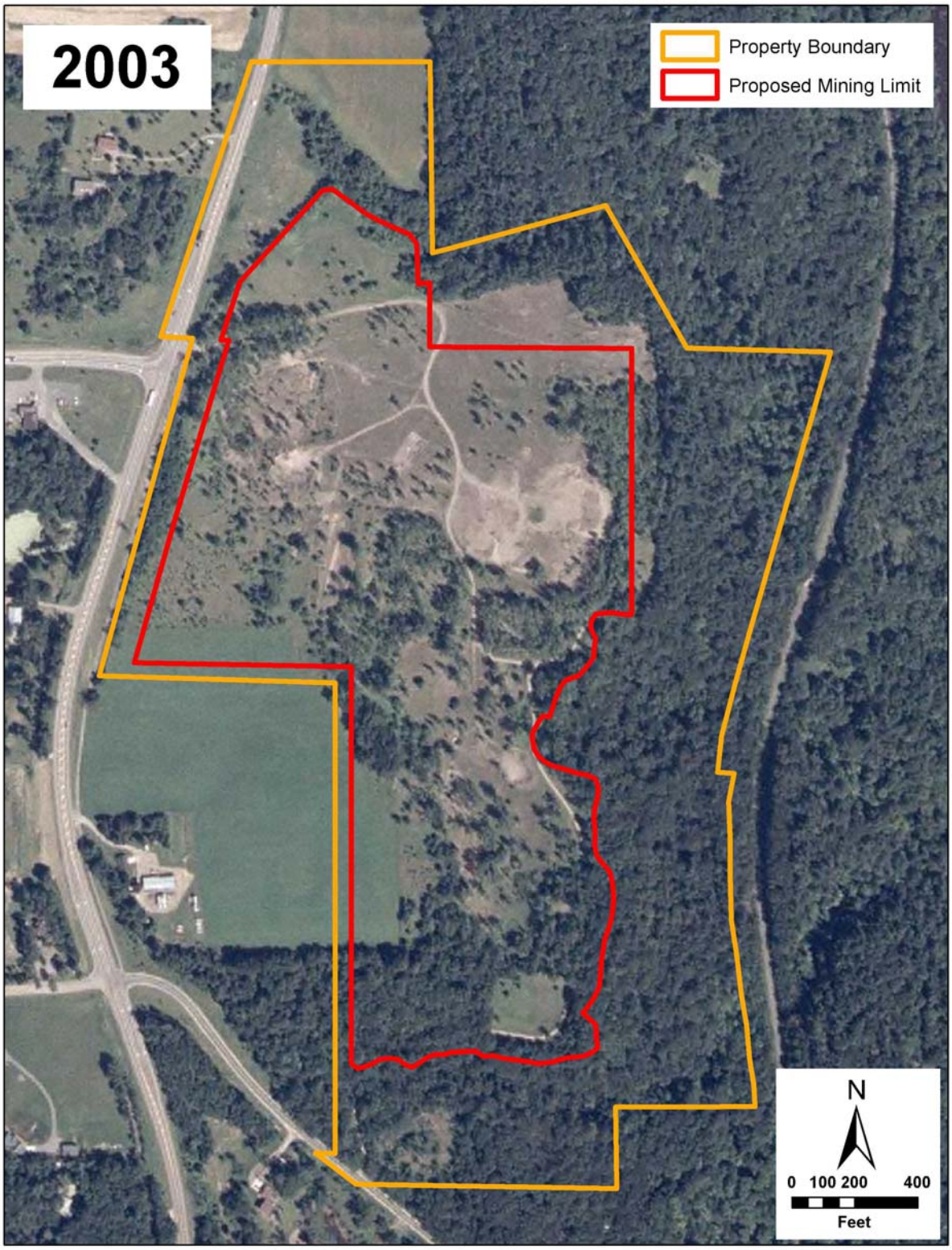
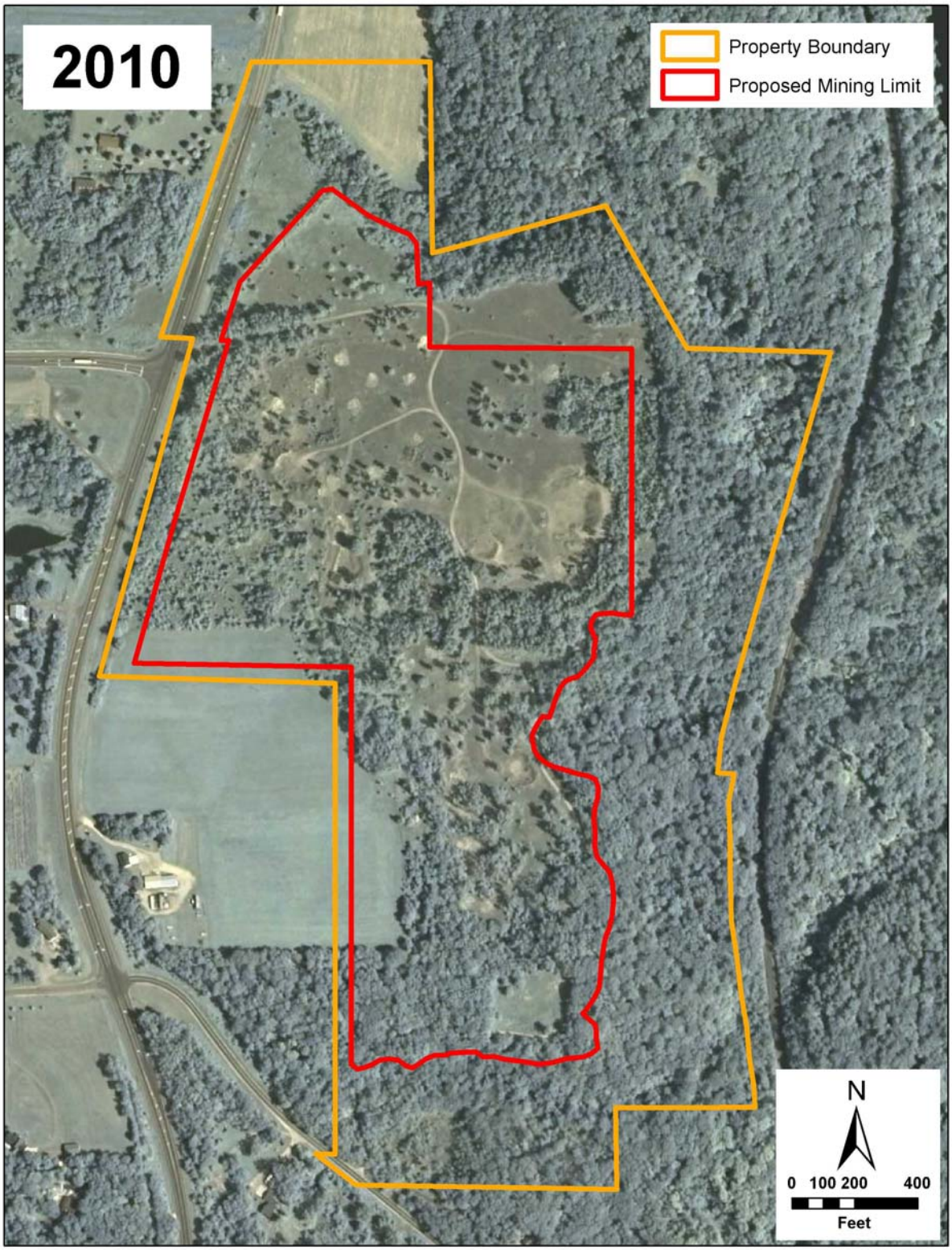
Feet


1991
Property Boundary
Proposed Mining Limit
N
0 100 200 400
Feet

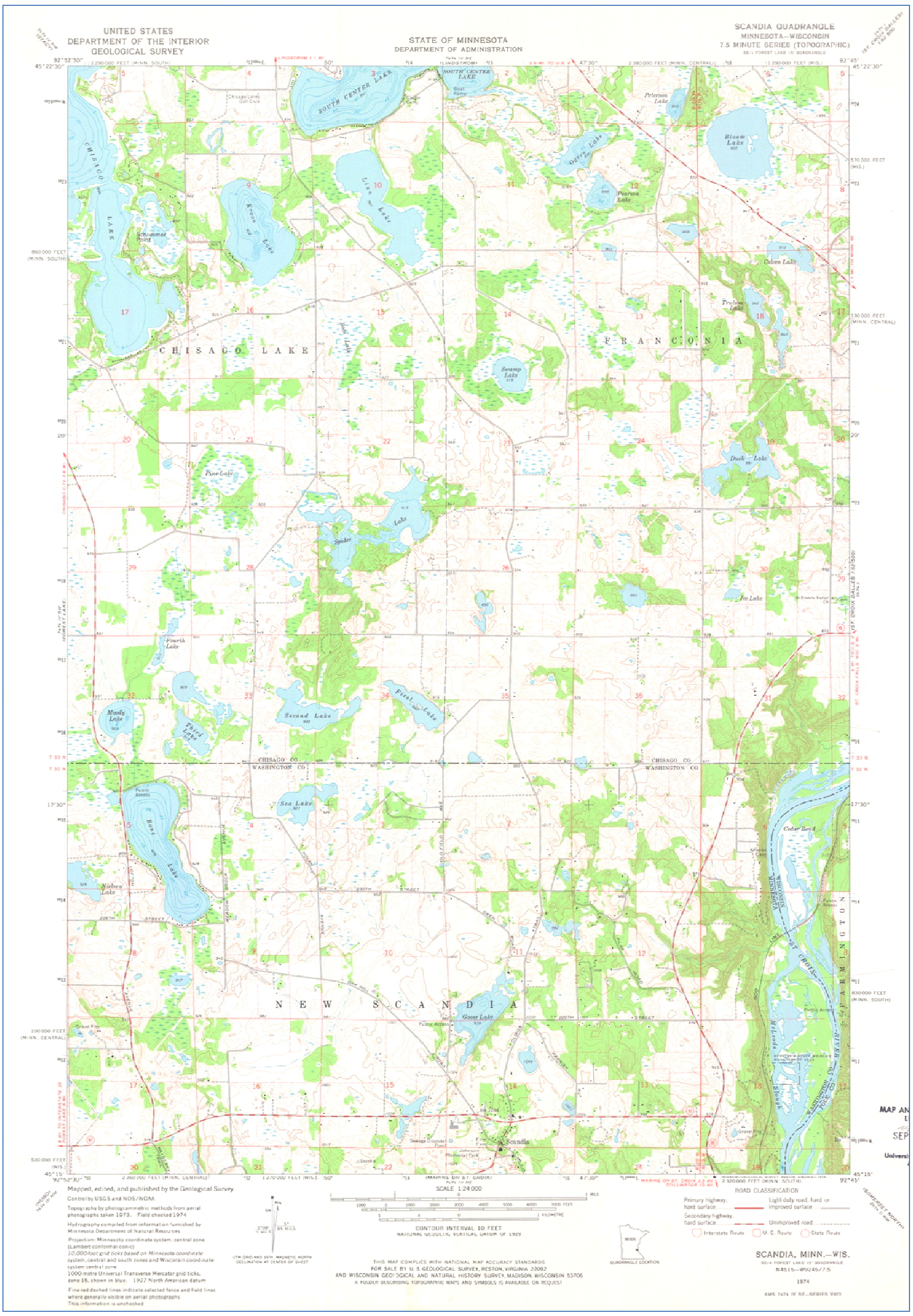

1997
Property Boundary
Proposed Mining Limit
N
0 100 200 400
Feet


2003
Property Boundary
Proposed Mining Limit
N
0 100 200 400
Feet

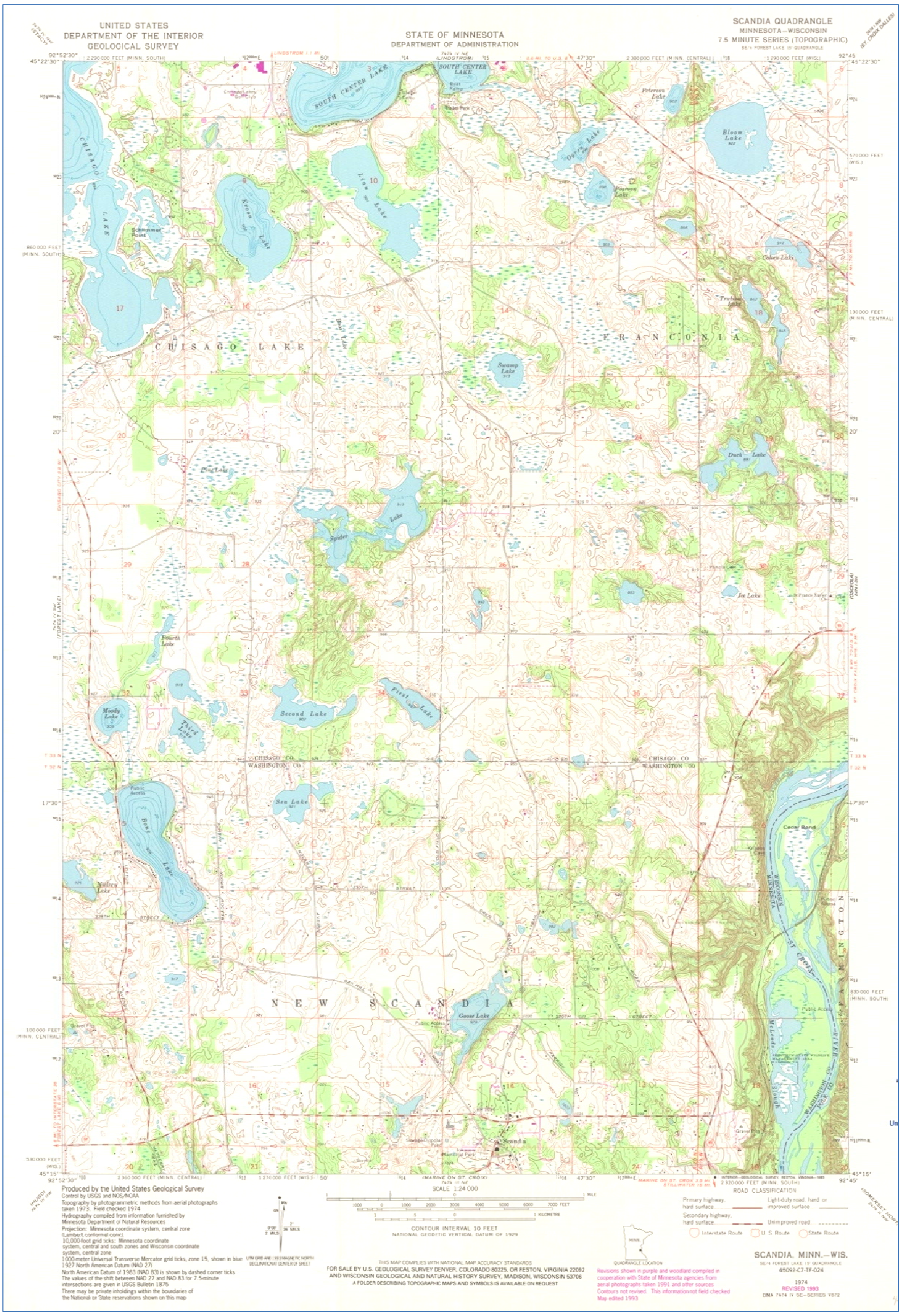

2010
Property Boundary
Proposed Mining Limit
N
0 100 200 400
Feet

Appendix C. Historical Topographic Maps

1974 USGS Topographic Map



1993 USGS Topographic Map



2010 USGS Topographic Map

Kim Alan Chapman, Ph.D.

Principal Ecologist

EDUCATION

Ph.D. in Conservation Biology, 2001
University of Minnesota

M.A. in Biology (Ecology), 1984
Western Michigan University

B.A. in Biology, 1979
Kalamazoo College

AFFILIATIONS

Ecological Society of America

Natural Areas Association

American Society of Landscape Architects

QUALIFICATIONS AND COMPANY ROLE

Before joining AES in 2003, Kim worked in the non-profit sector and taught at Macalester College, the University of St. Thomas, and University of Minnesota. With 25 years experience in applied ecology, he works with groups and organizations in finding ways to design, build, and live sustainably. Conservation design, ecosystem restoration, green planning, sustainability, and wildlife are his specialties. Kim's book on prairie, *Valley of Grass*, won a Minnesota Book Award. He directs the AES Minnesota consulting office, and lives in St. Paul with his wife and children.

SELECTED PROJECTS

- *Conservation Design Neighborhoods.* Design, permitting, and construction oversight for several developments in Minnesota, Colorado and Pennsylvania. These neighborhoods created wildlife habitat, restored ecosystems, regulated stormwater runoff ecologically, and provided for perpetual ecosystem management.
- *University Land Master Plan.* Part of a team creating a new sustainable community for a major university. The AES project focus is water use and re-use, stormwater, wildlife habitat design, and a research agenda for sustainability.
- *Avon Hills Initiative*. Partnering with St. John's University and The Nature Conservancy, this effort makes new development compatible with the preservation of natural resources and rural character on 90,000 acres in Stearns County, Minnesota.
- *Maplewood Greenway Plan.* Retrofitting an urban community with corridors and preserves to support disappearing wildlife.
- *Green Planning for Communities.* Several projects in the Twin Cities, Minnesota (with partner Dahlgren Shardlow Uban) to identify green infrastructure and bring ecosystem protection and restoration into development and recreation planning.
- *Vermillion River Temperature Trading Project.* Funded by the US EPA through the Vermillion River Watershed Joint Powers Organization, AES and its partners developed the scientific foundation for a market trading program in temperature to protect a major trout stream in the Twin Cities, Minnesota.
- *Forest Legacy Program.* With the Minnesota Forest Stewardship Committee, established the Forest Legacy Program which directed millions in federal and local dollars to protecting timber harvesting on thousands of acres of productive forest land in Minnesota.

Douglas M. Mensing, M.S.

Senior Ecologist

EDUCATION

M.S. in Conservation Biology, 1997
University of Minnesota

B.S. in Environmental Science, 1991
Valparaiso University

PROFESSIONAL INFORMATION

Minnesota Land Cover Classification System (MLCCS) Training

Protecting Water Resources through Low Impact Development (LID) Workshop

Wetland Delineation Training with an Emphasis on Soils and Hydrology

AFFILIATIONS

Embrace Open Space/Regional Greenways Collaborative (former Steering Committee)

Growth Corridor Initiative (Advisory Committee)

Minnesota Native Plant Society

QUALIFICATIONS AND COMPANY ROLE

Doug has over 15 years of professional and research experience in the ecological and environmental fields. He has applied expertise in: conservation planning, design, and development; low impact development (LID); multifunctional greenway corridor design; alternative/ecological stormwater management techniques; environmental review documents (e.g., AUAR, EAW); ecological inventory, assessment, restoration, monitoring, and management; natural resource damage assessments; wetland determinations, delineations, assessment, permitting and mitigation; wetland mitigation banking and monitoring; wetland vegetation and water chemistry monitoring; lakeshore and streambank restoration and bioengineering techniques; flora and fauna surveys; bioassessment techniques; and geographic information systems (GIS). As a consulting ecologist, Doug manages and provides technical support for a broad range of these types of ecological projects. Much of Doug's recent projects have focused on working with clients to design projects in a more ecologically sensitive fashion, conserving natural features and functions.

SELECTED PROJECTS

- *I-35E Corridor Alternative Urban Areawide Review (AUAR).* Project manager, natural resource inventory (NRI), conservation design framework, and mitigation plan. Lino Lakes, Minnesota
- *Wild Meadows Conservation Development.* Project manager for ecological stormwater management monitoring. Medina, Minnesota
- *Dean Lakes Mixed Use Development.* Project manager, ecological restoration & management program, monitoring. Shakopee, Minnesota
- *Scott County MLCCS Update (184 sq mi).* Project manager, lead ecologist, QA/QC. Scott County, Minnesota
- *Victoria Southwest Area AUAR.* Project manager, NRI, mitigation plan. Victoria, Minnesota
- *Twin Cities Army Ammunition Plant (TCAAP) Redevelopment Master Plan.* Project manager, NRI, conservation planning. Arden Hills, Minnesota
- *Lebanon Hills Regional Park Master Plan.* Project manager, NRI, master planning, native landscaping, and wetland issues. Eagan and Apple Valley, Minnesota
- *Assessing Wetland Quality with Ecological Indicators.* Minnesota